

CONCRETE AND CONSTRUCTIONAL ENGINEERING

AUGUST, 1950.



Vol. XLV, No. 8

FORTY-FIFTH YEAR OF PUBLICATION

PRICE 1s. 6d.

ANNUAL SUBSCRIPTION 15s., POST FREE. \$3.90 in Canada and U.S.A.

LEADING CONTENTS

	PAGE
The Trials of the Concrete Maker	265
Square Columns Subjected to Combined Stress. <i>By Donovan Lee, B.Sc., and Oliver Cundall, B.Sc.(Tech.)</i>	267
Slabs Spanning in Two Directions. <i>By Professor H. Craemer</i>	279
Reinforced Concrete Residential Flats at Pimlico, London	283
Construction with Moving Forms.—VI. <i>By L. E. Hunter, M.Sc.</i>	291
A Test of a Prestressed Concrete Railway Bridge Girder	296
Variables in Concrete Making	300

No. 513

ISSUED MONTHLY

Registered for
Canadian Magazines Post

BOOKS ON CONCRETE

For catalogue of "Concrete Series" books on concrete and allied subjects, send a postcard to:

CONCRETE PUBLICATIONS LTD., 14 DARTMOUTH ST., WESTMINSTER, S.W.1



For nearly 60 years

this trade mark has stood for speed and
strength in reinforced concrete work.

DRAGON

(Brand)

PORTLAND CEMENT

Supplied by

THE SOUTH WALES PORTLAND CEMENT & LIME CO. LTD.
PENARTH, SOUTH WALES

Telephone : Penarth 300

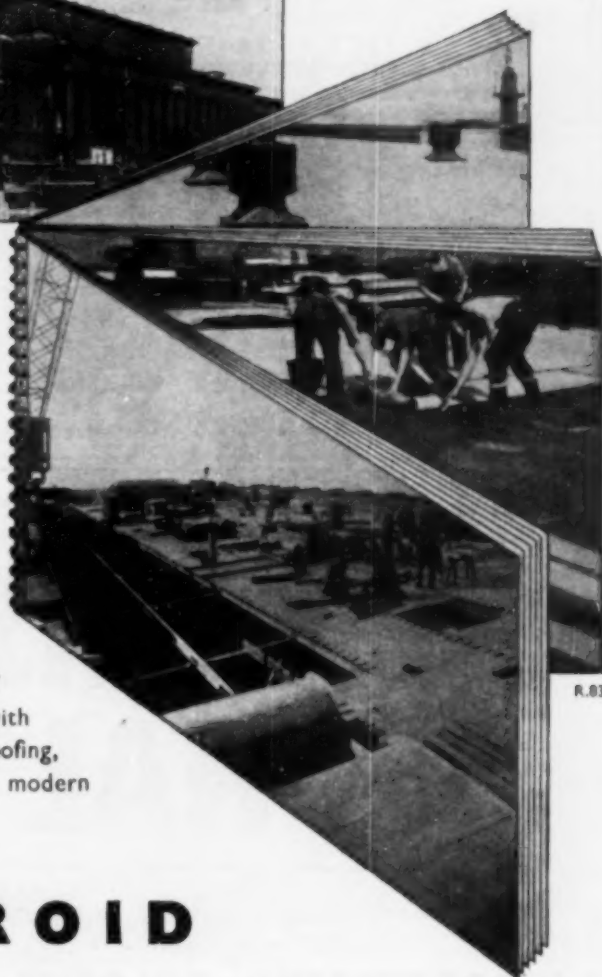
Telegrams : "Cement, Penarth"

THE STORY OF A ROOF



St. George's Hall, Liverpool, completed in 1854, provides a classic example of Greek architecture adapted to modern requirements.

It is perhaps fitting that the massive timber roof destroyed by fire in 1941 should have been replaced by one of steel fireproof construction and covered with Ruberoid Insulated Metal Roofing, the most effective of the modern roofing systems.



RUBEROID ROOFING

THE RUBEROID COMPANY LIMITED
16, COMMONWEALTH HOUSE
1-19 NEW OXFORD STREET, LONDON, W.C.1

*Photographs are reproduced by the courtesy of
Ronald Bradbury, Ph.D., F.R.I.B.A., A.M.T.P.I.
City Architect, Liverpool Corporation.*

Architects and Engineers are
invited to write for the range
of Ruberoid Technical Catalogues.

8 reasons for using

DAREX
AEA
in concrete
It—

- | | |
|--|---|
| 1. Enables water-cement ratio to be reduced. | 2. Increases plasticity and improves workability. |
| 3. Requires less spading or vibration. | 4. Minimizes patching and rubbing. |
| 5. Reduces "bleeding." | 6. Is quicker to finish. |
| 7. Gives better surface texture. | 8. Is more durable and watertight. |

Supplies now available, ask for information

DEWEY & ALMY LTD

ELVEDEN RD., PARK ROYAL, LONDON, N.W.10. Phone: ELGar 5671

COLOURS *for* ASPHALT

Introducing a new range specially prepared for ASPHALT by the Manufacturers of the well-known

"SHADEACRETE" COLOURS FOR CEMENT

LET US SEND YOU SAMPLES AND PRICES OF

RED • BLUE • YELLOW • GREEN • BROWN

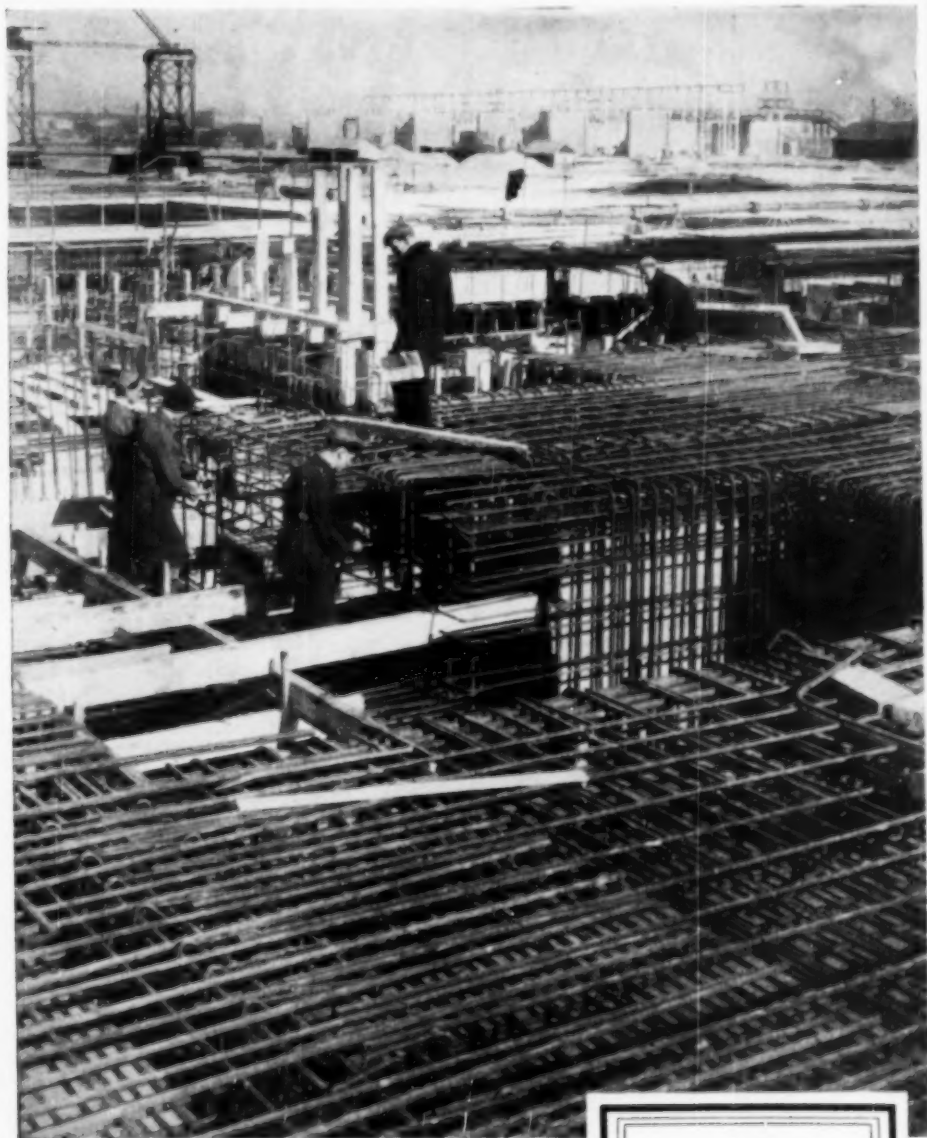
W. HAWLEY & SON, LTD.

Colour Works, DUFFIELD, Derby

COLOUR MAKERS SINCE 1838

Phone: Duffield 2294/5

Grams: Hawley, Duffield



Consulting Engineers: W. S. Atkins & Partners

*Construction of heavy reinforced concrete foundations
for the Cold Reduction Plant at Abbey Works for the
Steel Company of Wales Limited.*

*John Laing and Son Limited - Building and Civil Engineering
Contractors, London, Carlisle, Lusaka, Johannesburg.*

LAING

For a **REALLY**
Permanent
Way —



Photograph by
permission of
Railway Executive

CONCRETE SLEEPERS

British Patents Nos. 569573-16779/43
and Patented in other countries

★ **pre-stressed**
positive anchorage

a logical modern development
by **STENT**

STENT PRECAST CONCRETE LTD.

Sales: 1, Victoria St., London, S.W.1
Telephone: Whitehall 2573

Works: Dagenham Dock, Essex
Telephone: Rainham (Essex) 780

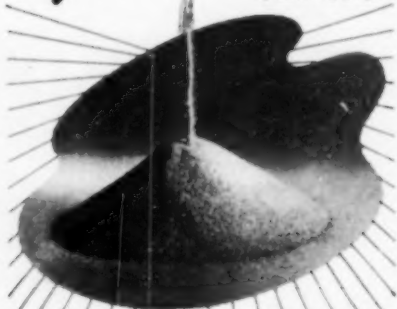
Agents for Wales and South-West England: T. L. LOWE, Esq.,
B.Sc.Eng., A.M.I.C.E., M.Inst.M.E.; DAVIES, MIDDLETON
& DAVIES, LTD., 9, Museum Place, CARDIFF. Telephone:
Cardiff 2370/1.

Midland Agent: FABIAN J. M. JACKSON, M.In.B.E.,
M.I.P.E., 11, Leicester Rd., LOUGHBOROUGH. Tele-
phone: Loughborough 3781 & 3543. 56, St. Mary's Rd.,
MANCHESTER, 10. Telephone: FAI 2623.

L295B

Grey Iron Powder (SINTREX BRAND)
for floor hardening

Free from oil, dirt and
non-ferrous metal. Con-
tains only a minimum
of adhering graphite.

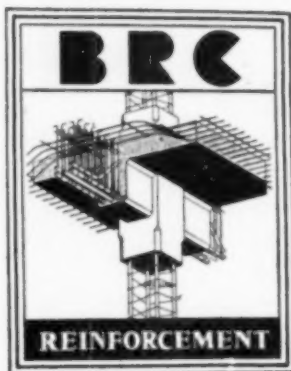


GEORGE COHEN Sons & Co. Ltd
BROADWAY CHAMBERS LONDON W.6

Telephone: Evesham 4117

600
GROUP

CCE/4911/IFI7



BOOKS ON CONCRETE

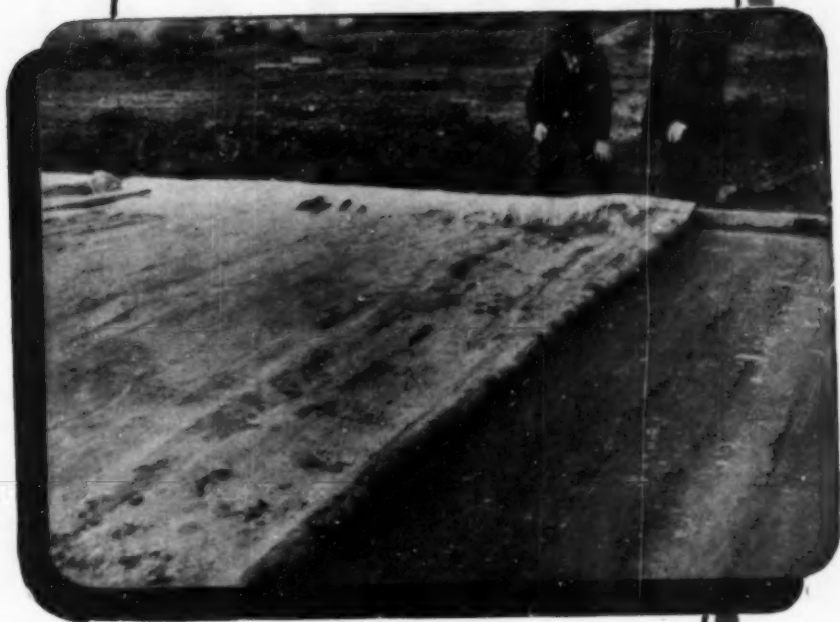
"CONCRETE SERIES"

books on concrete are available on
practically every aspect of the design
and construction of reinforced con-
crete and precast concrete, the
manufacture and chemistry of
cement, and kindred subjects. For a
complete catalogue giving prices in
sterling and dollars, send a postcard to:

CONCRETE PUBLICATIONS, Ltd.
14 Dartmouth St., London, S.W.1
England

SISALKRAFT CONCRETE CURING BLANKETS

(PREFABRICATED)



*Note sweat on surface of concrete road slab and on upturned
Sisalkraft (dark patches) after several days covering.*

SIMPLICITY . . . Efficiency . . . Economy . . .
SISALKRAFT—the supreme building paper—made into
blankets of any size, has become the accepted method of concrete
curing and FROST PROTECTION. Specified and used by
an ever-increasing number of Authorities and Contractors.
Technical information and samples on request.

SISALKRAFT
TRADE MARK

Sole Distributors for
British Sisalkraft Ltd.

J.H. SANKEY & SON. LTD.

ALDWYCH HOUSE, ALDWYCH, LONDON, W.C.2

Telephone: Holborn 6947.

Telegrams: Brickwork, Estrand, London.

BUILDING AND CIVIL ENGINEERING

REINFORCED AND PRESTRESSED CONCRETE

DOUGLAS

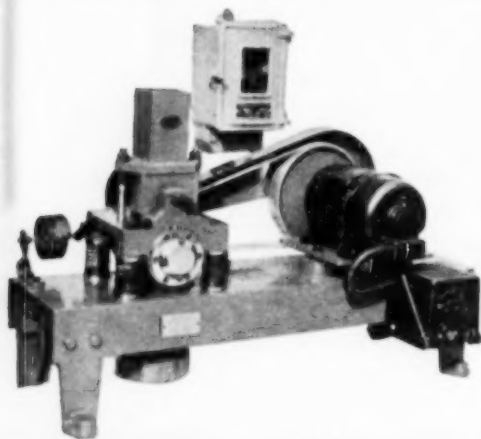
PILING • HEAVY FOUNDATIONS • ROADS • BRIDGES • AIRFIELDS
FACTORIES • SEWERS • RAILWAYS • BUNKERS • COFFERDAMS

ROBERT M. DOUGLAS (CONTRACTORS) LTD.

305 GEORGE ROAD, BIRMINGHAM, 23

Telephone : Birchfields 4541

"CAPCO" H. F. VIBRATOR



for compacting mortar cubes
for Compression Test B.S.
12/1947, B.S. 915/1947,
B.S. 146/1947, B.S.
1370/1947 with automatic
time control device. The
vibrator illustrated in the
B.S. was built in our works.

The "CAPCO" range of concrete testing apparatus also includes Cube Moulds; Slump Cones; Tensile, Vicat, and Cylindrical Moulds; Tile Abrasion Machines; Compacting Factor Apparatus.

Full details on request.

CAPCO (SALES), LTD.

BRACONFIELD ROAD, LONDON, N.W.18. Telephone : WILLESDEN 0047-8. Cable : CAPLINKO, LONDON

(Sole Agents for all
"Capco" Products)

SUPER CEMENT

'SUBMARINE' BRAND

THE TANNO-CATALYSED PORTLAND CEMENT

SAVES TIME

SAVES TROUBLE

NATURALLY WATERPROOF. CONTAINS NO WATER REPELLENT MATERIAL

Uses:—

For CONCRETE

Provides a CONCRETE of great strength at early dates and impervious to water, oil, etc., without any form of surface coating.

For PAVING

Produces a hard wearing PAVING, dustless and proof against penetration by water, etc.

For RENDERING

Supplies an impenetrable RENDERING of such adhesive power that a 1" thickness will resist an outside pressure of at least a 20' head of water.

For SLURRY (as paint)

Makes a perfectly watertight covering to brick or breeze concrete walls at very small cost, and also provides the best watertight undercoat to coloured finishes.

Technical Information is available to users.

Used in 1914-1918 and still used by:

Air Ministry, War Office, Admiralty, Ministry of Works, Ministry of Supply, etc.

SUPER CEMENT LTD.,

29 TAVISTOCK SQUARE,
LONDON, W.C.1

Phone:

Euston 1808



**PIN YOUR FAITH
TO THE TESTED
BRAND.**

THIS LABEL ON
EVERY BARREL
CARRIES WITH IT
FORTY YEARS'
EXPERIENCE OF
MANUFACTURE.

**NONE OTHER IS
"JUST AS GOOD"**

THE LEEDS OIL & GREASE CO.

LEEDS

'Phone: 22480.

'Grams: "Grease."

HAYWARDS "CRETE-O-LUX" LIGHTS



"Crete-o-Lux" Precast Reinforced Concrete Lights meet all modern needs. Illustrated above are "Crete-o-Lux" Roof Lights, "Ninex-Double" type.
Enquiries invited for any requirements.

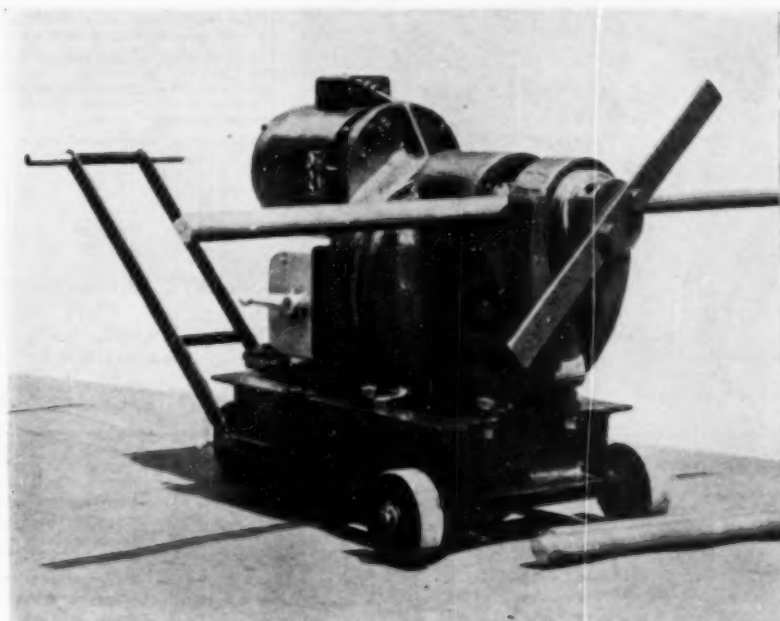
HAYWARDS LTD., UNION STREET, LONDON, S.E.1

WATERloo 6035-6039



PRESENT THE NEW HYDRAULIC BAR CROPPER

THIS UNIQUE MACHINE WORKS ON AN ENTIRELY NEW PRINCIPLE



**CUTS $1\frac{3}{4}$ " MILD STEEL IN 2 TO 3 SECONDS
OR SEVERAL SMALLER BARS**

VERY EFFICIENT ——— LARGE DAILY OUTPUT

SIMPLE AND SAFE TO OPERATE

CUTS ROUNDS, SQUARES, FLATS AND HEXAGONS

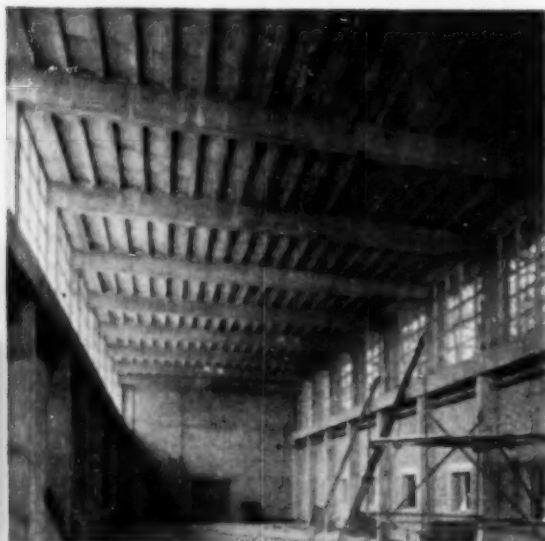
E. P. ALLAM & CO. LTD.

Manufacturers of vibrating tables, internal vibrators, external vibrators, petrol and electric vibrating tampers, vibrating screens, pan vibrators, electric motors, petrol engines, builders' hoists and winches, and hydraulic bar croppers.

LONDON: 45 Great Peter Street, S.W.1. Telephone: Abbey 6353 (5 lines)

SCOTLAND: 39 Cavendish St., Glasgow, C.S. Tel.: South 0190. Works: Eastwood, Southend-on-Sea. Tel.: Eastwood 00243

PRESTRESSED CONCRETE ROOF UNITS



Roof Beams up to 65 ft. span are produced at our factory and transported to the site for easy erection by the contractor.

The illustration, by courtesy of the Cement and Concrete Association, shows medium span beams 30' 6" long, together with purlins and precast concrete slabs, supplied to their new laboratory at Fulmer.

The economical design of prestressed concrete beams depends upon a number of factors. The experience of our technical staff is at your service.



**CONCRETE DEVELOPMENT CO.
TD.**

THORNEY LANE, IVER, BUCKS

Telephone: IVER 809

London Office: One Queen Anne's Gate,
Westminster Telephone: Whitehall 3111

E.L.B.
Wire Ties

20 to 30
Ties per minute

ENGINEERS SPECIFY THEM because reinforcement is securely fixed without fear of displacement by rough usage, tamping, or vibration. No snipped ends are left to cause rust marks.

CONTRACTORS PREFER THEM because they are cheaper and fixed more easily and quickly than any other type. Test them on your next contract at our expense.



... SAVE TIME, LABOUR & MATERIALS

I.S. & G. MERCHANTS LTD.
(Formerly EDWARD LE BAS & CO., LTD.)

14 FINSBURY CIRCUS,
LONDON, E.C.2
Phone: London Wall 6905.
Grams: Gramercy, London.

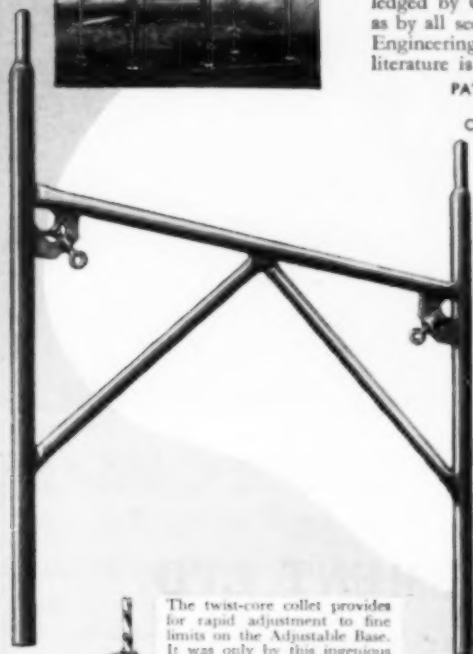
KWIKFORM



... the Unit-Frame Scaffolding System...

... has revolutionised all previous conceptions of scaffolding. Economies obtained from its usage have been officially acknowledged by Government Authorities as well as by all sections of the Building and Civil Engineering Industries. Fully descriptive literature is available on application.

PATENTS GRANTED AND PENDING IN ALL PRINCIPAL COUNTRIES OF THE WORLD.



The twist-core collet provides for rapid adjustment to fine limits on the Adjustable Base. It was only by this ingenious "Kwikform" invention that the scaffolding problems of the building industry could be brought within the scope of full-scale factory prefabrication with all its benefits.



Illustrated above is the adaptability of our Unit-Frame System to extremely difficult site conditions.



The above photograph of Nechells Power Station reproduced by permission of the British Electricity Authority shows the application of our Unit-Frame System to external and internal large-scale constructional operations.

KWIKFORM LTD.

WATERLOO ROAD, BIRMINGHAM, 25. London Office: 66 Victoria Street, S.W.1

L.G.B.



ALPHA CEMENT LTD

PORTLAND HOUSE, TOTHILL STREET

LONDON, S.W.1.

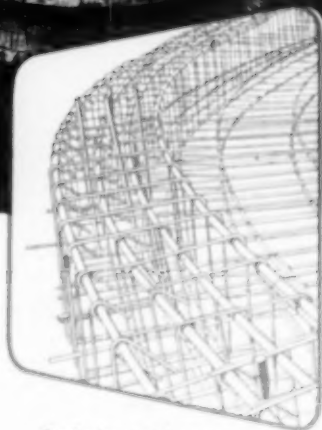
Telephone - Abbey 3456.



REINFORCEMENT

for all ferro-concrete work

The illustration shows reinforcement work in course of construction for two circular sedimentation tanks which form a part of the City of Hereford New Sewage Scheme. The whole of this reinforcement was supplied, bent and fixed by T. C. Jones & Co., Ltd.



City Engineer and Surveyor:
F. MARGERISON, A.M.I.C.E., M.I.Mun.E.,
M.I.W.E.

Consulting Engineers:
MESSRS. L. G. MOUCHEL & PARTNERS,
LTD.

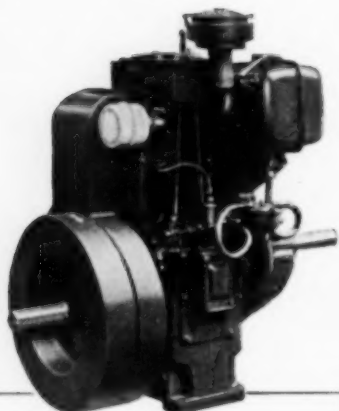
Main Contractor:
MESSRS. M. J. GLEESON, LTD.

T.C. Jones & Co. Ltd **600**
STRUCTURAL & REINFORCEMENT ENGINEERS **GROUP**

A complete service is available for the design, supply, bending and fixing of steel reinforcements
WOOD LANE, LONDON, W.12. Telephone: *Shepherds Bush* 2020 • BUTE STREET, CARDIFF • TREORCHY, GLAM.

CCE/505/JR7

There's a **PETTER** engine for every purpose...



With 50 years' experience behind them Petters give the answer to a world-wide demand for an Air-cooled Diesel. Petters justly claim to manufacture the most comprehensive range of small engines in the country.

There are literally hundreds of alternatives — petrol, diesel or vapourising oil, air-cooled or water-cooled, direct drive or clutch, right-handed or left-handed, at half-speed or full-speed, $1\frac{1}{2}$ to 40 h.p. — it's endless. But don't be bewildered! Bring your problem to Petters, and they will give the answer. Ask also about Petter Service and Replacement Engine Scheme — it's the best in the country!

This is the new air-cooled diesel

The AVA is the air-cooled version of the famous Petter AV Series II. The single-cylinder engine develops 3–4½ h.p. at 1000–1500 r.p.m., or 500–750 r.p.m. at half-speed shaft, while the twin-cylinder model develops 6–9 h.p. at the same speeds.
NO BOILING—NO FREEZING

ONLY £64.0.0

Specify PETTER
the engine
that costs less

PETTERS  LIMITED

Small Engine Division, Causeway Works, Staines, Middlesex. Tel. Staines 1122

One of the **ASSOCIATED BRITISH OIL ENGINES Group**

SINEX VIBRATORS for CONCRETE ROADS and STRUCTURES

Sinex Electric Vibrators of the pin fixing type are used for compacting concrete roads and structures all over the world. They are extremely simple to attach to any road tamper by means of an eccentric pin and bracket, and can be utilised for shutter vibration by this same method of attachment.

Sinex Vibrators can be supplied for any A.C. voltage required, and where an electric supply is not available, we can provide Petrol Electric Generators suitably wound.

Our illustrations show two typical examples of the uses of these Multi-Purpose Machines.

SINEX ELECTRIC IMMERSION VIBRATOR

This illustration shows a Sinex 80-watt electric vibrator mounted on a rigid steel lever for use in immersion vibration. This method was used very largely on the Mulberry Harbour and has since been adopted at various contracts in this country and abroad, and is universally accepted where shutter vibration is not required.



SINEX SURFACE TAMPER

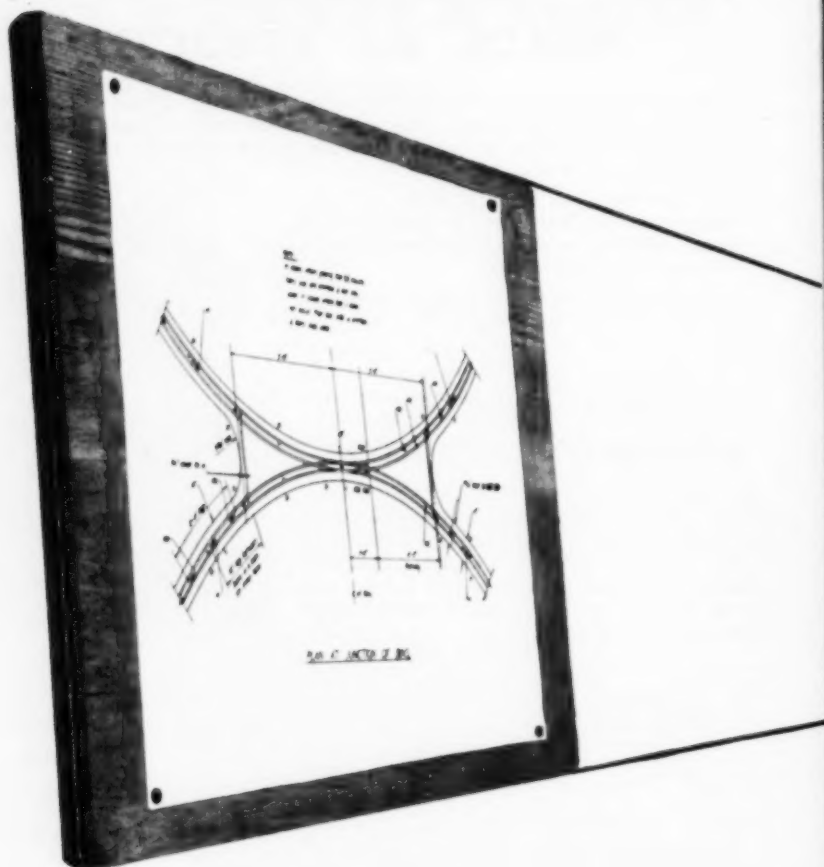
Illustration shows Sinex pin fixing Vibrator mounted on Surface Tamper. Vibrators can be supplied separately for fixing on to tampers constructed by the contractor or tampers can be supplied complete to customer's specification. Generators can also be supplied when electric supply is not available.

Our Technical Representatives will be pleased to call to discuss any concrete placing problems.

CONCRETE VIBRATION LIMITED

2 CAXTON STREET, WESTMINSTER, S.W.1

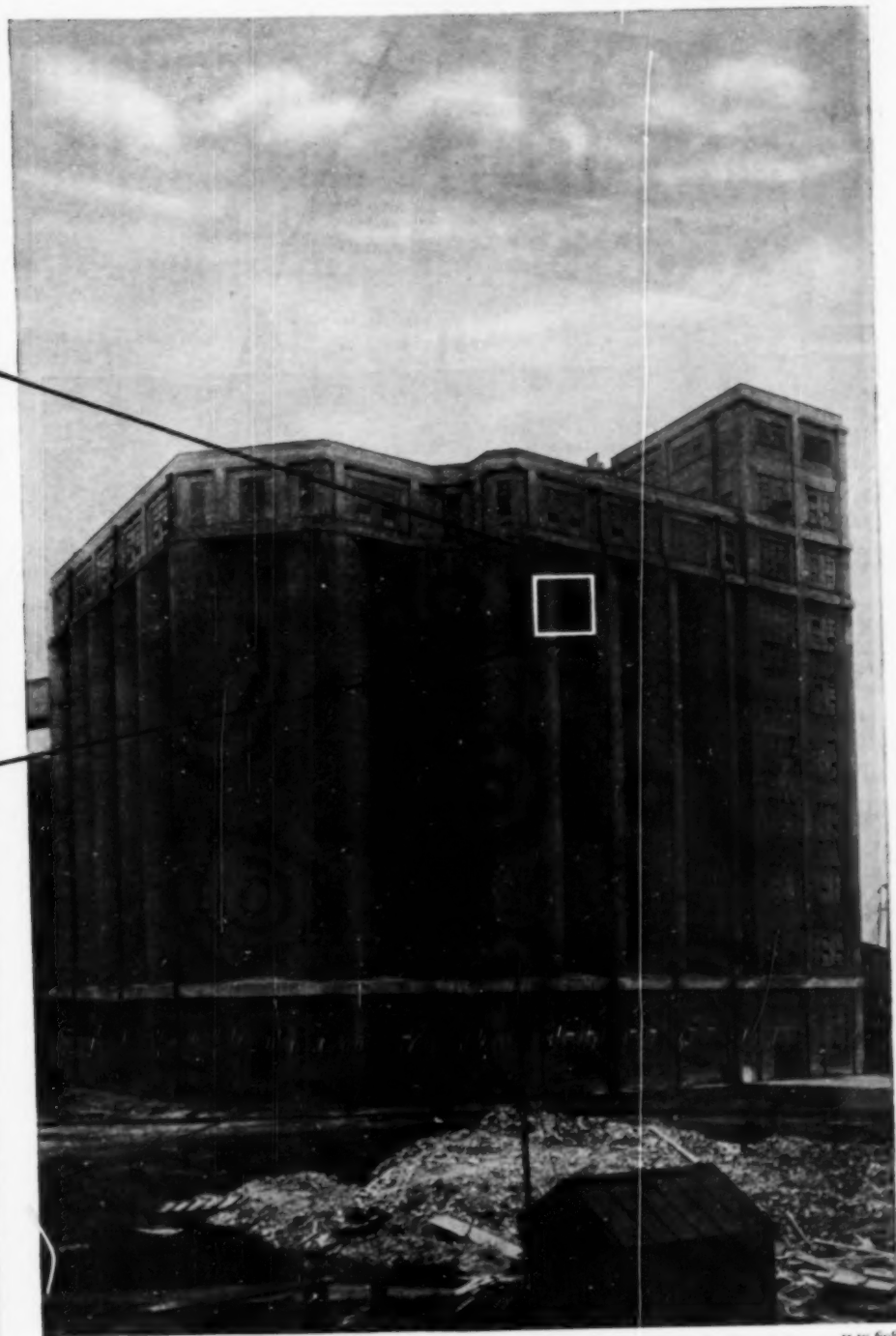
Tel.: VIC 3265 & 7131



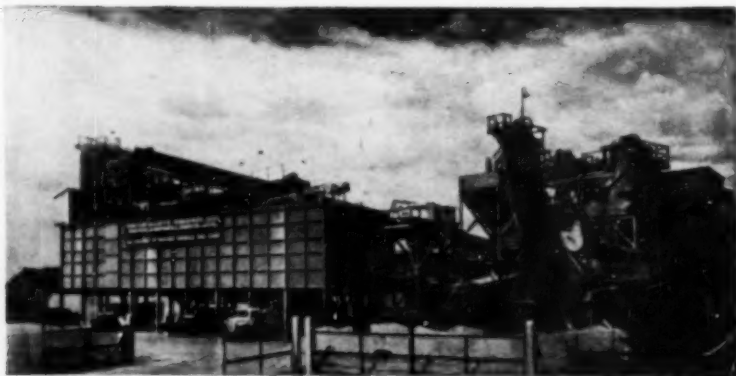
BRC

brings the accuracy of
the drawing board to the job

Issued by **THE BRITISH REINFORCED CONCRETE ENGINEERING CO. LTD., STAFFORD**
Specialists in Reinforced Concrete Design & Suppliers of Reinforcement
London, Birmingham, Bristol, Leeds, Leicester, Manchester, Newcastle, Sheffield, Cardiff,
Glasgow, Dublin, Belfast



STONE COURT AGGREGATES



General View of Plant at Rickmansworth.

ONE OF OUR MODERN CONCRETE AGGREGATES PLANTS

High-grade concrete aggregates graded to any specification, and the most punctual delivery service in England, can now be given to all Contractors, Builders, and Municipal Authorities carrying out concrete work and road construction in London and Suburbs and the Home Counties.

Washed all-in Ballast 2 in. down.

$\frac{3}{4}$ in. Washed & Crushed or Un-crushed Shingle.

$\frac{1}{2}$ in. Washed & Crushed or Un-crushed Shingle.

Washed Pit Sand.

Soft Sand.

$\frac{3}{16}$ in. Crushed Grit.



STONE COURT BALLAST CO. LTD.

PORTLAND HOUSE, TOTHILL ST., WESTMINSTER, S.W.1

Telephone: Abbey 3456.



prestressed and precast concrete for building and civil engineering



A symbol of quality materials, experienced workmanship, expert supervision, and excellent service.

We specialise in the production of prestressed and precast concrete structural members to standard or special designs, including railway sleepers, and shall be pleased to submit quotations for contracts in most parts of the country.

H. B. CONCRETE CO LTD

Head Office: East Street, Epsom, Surrey.
Telephone: Epsom 4041/4042.

Branch Works: Vicarage Road, Egham, Surrey.
Telephone: Egham 3092/3093.

REINFORCED CONCRETE

by



A. G. MANSELL & CO. LTD

CIVIL ENGINEERING AND BUILDING CONTRACTORS

BRIDGES - RIVER AND SEA DEFENCE WORKS - WATER TOWERS - BUNKERS
SILOS - INDUSTRIAL BUILDINGS - ROADS - FOUNDATIONS - AND PILING.

78 BUCKINGHAM GATE, LONDON, S.W.1.

TELEPHONE: WHITEHALL 8735-6-7.

SEALCRETE *and* SEALANTONE

*Make
Cement or
Concrete
what it
should be*

- ★ CASE HARDENED
- ★ WATERPROOF
- ★ DUST PROOF
- ★ COLOURFUL



Write for particulars of our SALES WITH SERVICE. Inventors and Sole Manufacturers :

SEALCRETE PRODUCTS LTD., ATLANTIC WORKS, MACBETH ST., LONDON. W.6

Tel. : RIVerside 2686, 2687 & 7275. Telegrams and Cables : "EXPLOITURE, LONDON."

A. E. FARR, LTD.

Station Road - WESTBURY - Wilts.

'Phone: WESTBURY (Wilts) 356 (5 lines)

and

2 Victoria Street, WESTMINSTER, S.W.1

'Phone: ABBEY 2008 (2 lines)

CIVIL ENGINEERING AND BUILDING CONTRACTORS

DEPARTMENTS:

1. CIVIL ENGINEERING.

Earth Moving and Levelling.
Pile Driving and Heavy Foundations.
Road and Bridge Building.
Sewers and Water Mains.
Tunnels and Outfalls.
Reservoirs and Water Towers.
Cooling Towers, Chimneys and Silos.
Wharves and Jetties.
Railway Sidings, etc.

2. BUILDING.

Factories, Offices, Schools, Garages, etc.

3. PLANT HIRE.

Excavators, Trenchers.
Bulldozers, Scrapers.
Dumpers, Rollers.
Compressors, Mixers.
Concrete Pumps.
Pile Frames.
Winches and Hammers.
Mobile Cranes, etc.

4. HEAVY HAULAGE.

Special Machinery Carriers and Low-Loading Lorries for carrying heavy plant and machinery up to 30 tons weight.

Dismantling and erection of heavy machinery undertaken.

INDUSTRIAL CONSTRUCTION

FACTORIES OFFICES
FOUNDATIONS

**KENT & SUSSEX
CONTRACTORS LTD.**

LONDON • SIDCUP • BIRMINGHAM

Government Factory and
Administrative buildings at
Chadwell Heath, Essex, by
Kent & Sussex Contractors

Associated Company - RUSH & TOMPKINS (S.A.) LTD. Durban Natal.

Where service counts

The following are a few of the contracts with which
'Twistee' Reinforcement Ltd. have recently been associated.

CRAWLEY DEVELOPMENT CORPORATION

Factories and Roads

C.A.V. LTD., ACTON, MIDDX.

New Factory

TECHNICAL COLLEGES

at Kelsterton, Kingston-on-Thames, Nuneaton, Portsmouth, Port Talbot, etc.

SOUTH EASTERN GAS BOARD, GREENWICH

Turbo Alternator House

JOHN LYSAGHT'S SCUNTHORPE WORKS, LTD.

New Rolling Mills including Railway Bridge in prestressed concrete

VAUXHALL MOTORS, LTD., LUTON, BEDS.

Extensions

HARLOW NEW TOWN DEVELOPMENT CORPORATION

Roads

1951 FESTIVAL OF BRITAIN SITE, SOUTH BANK



TWISTEE

REINFORCEMENT LTD.

LONDON: 43 UPPER GROSVENOR STREET, LONDON, W.1. Telephone: GROsvenor 1216
BIRMINGHAM: ALMA STREET, SMETHWICK 40, STAFFS. Telephone: SMethwick 1991
MANCHESTER: 7 OXFORD ROAD, MANCHESTER, 1. Telephone: ARdwick 1691
GLASGOW: MESSRS. JOHNSTONS & PATON LTD., 224 INGRAM STREET, GLASGOW, C.1. Tel: City 7661



Ferro-Concrete Bars on the Cooling Bed of the new Merchant Bar and Wire Rod Mill at Dalzell Steel Works.

The large tonnage produced in this Mill provides an opportunity to

FERRO CONCRETE CONTRACTORS

of obtaining prompt and efficient service of highest quality

REINFORCING BARS

Mild and High Tensile Steel in round or square section.

PLAIN or INDENTED

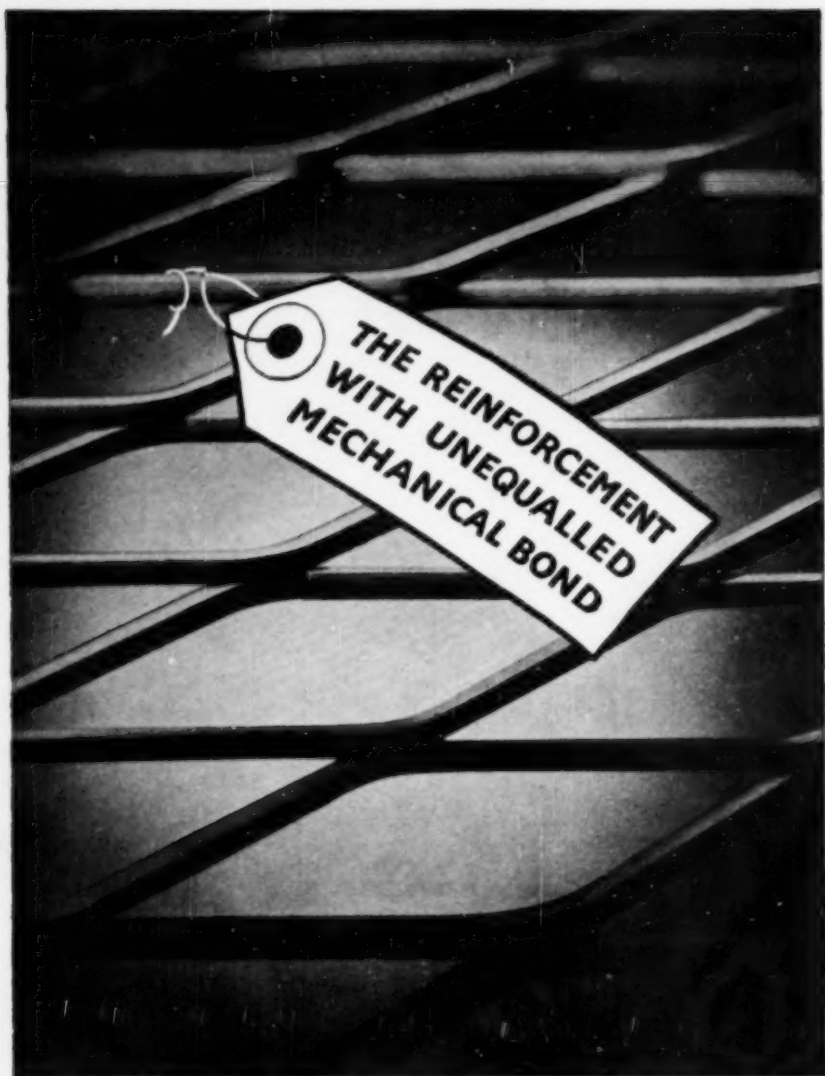
$\frac{1}{4}$ " and upwards in coils, straight lengths or hooked and bent ready for assembly.



COLVILLES STEELS

will serve you well

COLVILLES LTD 195 WEST GEORGE STREET GLASGOW C2



'EXPAMET' EXPANDED STEEL

The Expanded Metal Company, Ltd.,
Burwood House, Caxton Street, S.W.1. WHITEHALL 1736

STRANTON WORKS, WEST HARTLEPOOL, HARTLEPOOLS 2194

ALSO AT: ABERDEEN, BELFAST, BIRMINGHAM, CAMBRIDGE,
CARDIFF, EXETER, GLASGOW, LEEDS, MANCHESTER





Road bridge over river Tame, near Manchester. Joint consulting engineers: Messrs. G. B. Kershaw & Kaufman and Messrs. L. G. Mouchel & Partners, Ltd. The work was carried out to the general design and under the supervision of the Engineers and Surveyors to the Denton U.D.C., Mr. D. S. Graham, B.Sc., and Mr. J. B. Cooke.

PRESTRESSED CONCRETE BRIDGE

CONSTRUCTION AND PRESTRESSING BY

R. & T.

HOWARTH

LTD.

STRUCTURAL AND CIVIL ENGINEERING CONTRACTORS

CROSSFIELD WORKS, ROCHDALE.

'Phone: ROCHDALE 2227/9

*You dare not
trust to Luck—*



NOT WHERE CORROSION IS CONCERNED, ANYWAY!

For corrosion is no respecter of persons, and however fortunate you may be in other respects, unless you take preventive measures it will assuredly attack your concrete flooring, etc. It seeps in quite unobtrusively—but once established, quickly causes extensive and expensive damage before it can be checked.

Take action now—while your Works are still unaffected. Consult Windsor's. They are experts in anti-corrosion and provide a first-class service at most reasonable rates. Remember, prevention is better than luck—and far safer, so get in touch with Windsor's today.

H. WINDSOR & CO., LTD.

119, VICTORIA ST., LONDON, S.W.1. Tel.: VICTORIA 9331-2

748, FULHAM RD., LONDON, S.W.6. Tel.: REN 6006-7-8



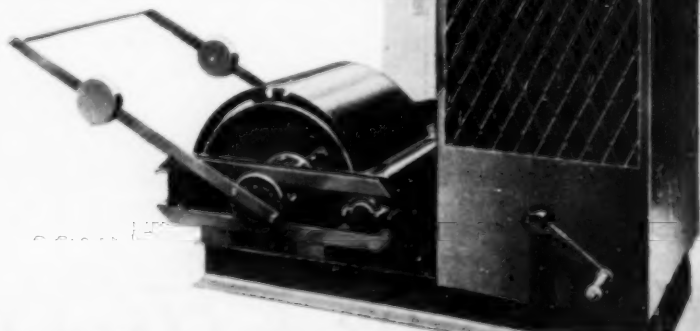
— THE BETTER JOB

**Builders and Contractors
everywhere increasingly
standardize on Wickham
Hoists and Winches**

a better, stronger and more reliable job

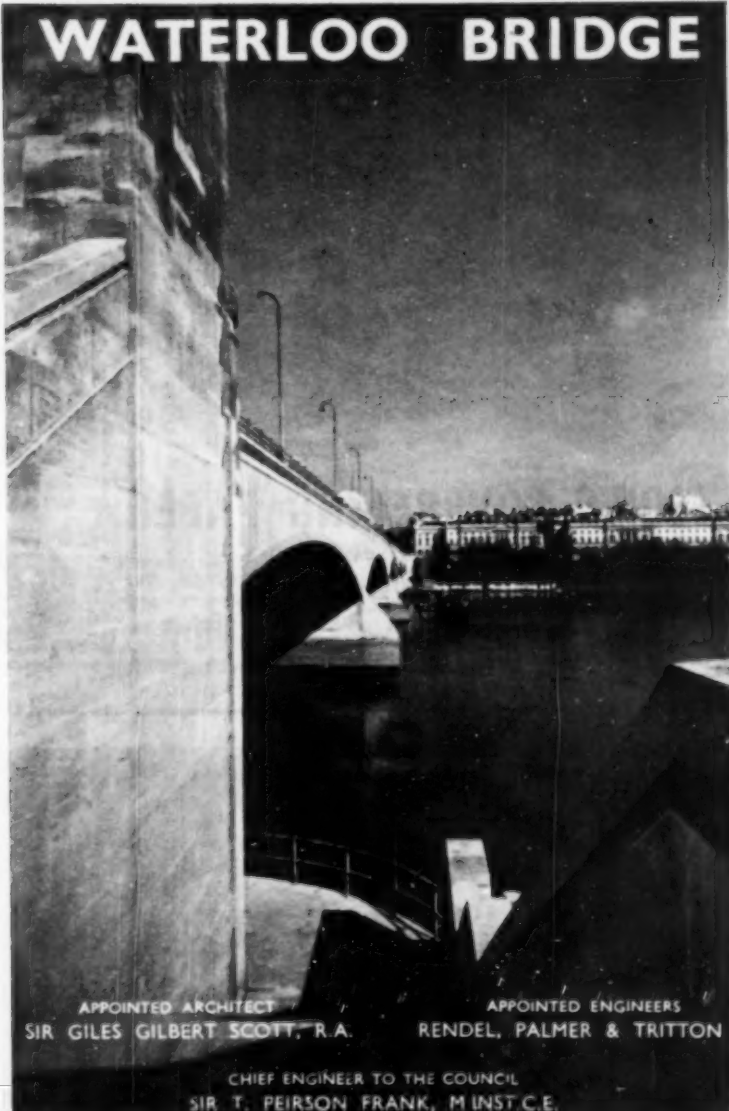
- The Wickham Builders' Hoists, all models, include
- A self-aligning quick fitting Tower Mast which takes SUBSTANTIALLY less time to erect.
- The Wickham Mast, because of its design and construction, has a SUBSTANTIALLY longer life.
- The Wickham Winch is fitted with heavy duty self-aligning ball-roller bearings which reduce SUBSTANTIALLY the annual cost of maintenance.
- The entire Winch and power unit is totally enclosed in a steel housing which reduces SUBSTANTIALLY the annual depreciation.
- Because of the protection afforded by the housing the Unit must have a SUBSTANTIALLY longer life.
- The Wickham Automatic Platform Control increases SUBSTANTIALLY the effective life of the Wire Bond.

And so — THE WICKHAM IS
— a better job.



Wickham ENGINEERING CO. LTD.
34 VICTORIA STREET LONDON SW1 ABB 5967-B

WATERLOO BRIDGE



APPOINTED ARCHITECT
SIR GILES GILBERT SCOTT, R.A.

APPOINTED ENGINEERS
RENDEL, PALMER & TRITTON

CHIEF ENGINEER TO THE COUNCIL
SIR T. PEIRSON FRANK, M.INST.C.E.

PETER LIND & CO., LTD

STRATTON HOUSE, PICCADILLY, LONDON, W.1

TELEPHONE: GROSVENOR 4601



ANDERSON'S CONCRETING PAPER

gives 100% protection to concrete road foundations. It prevents the water from leaving the concrete before it is properly hardened, and insulates the foundation and reinforcement against moisture and impurities in the subsoil. Send for samples and particulars.

Supplies can be obtained through Builders' Merchants.

D. ANDERSON & SON, LTD., STRETFORD, MANCHESTER
ROACH ROAD, OLD FORD, LONDON, E.3

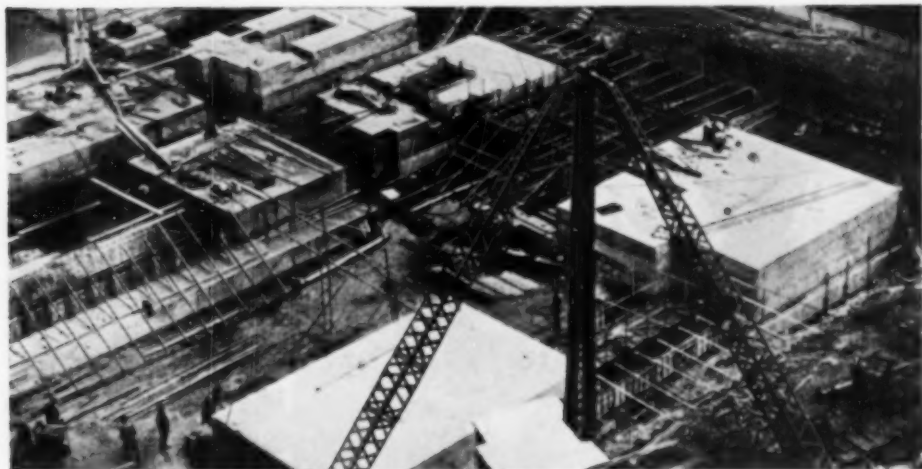
FLEXPAND
EXPANSION
JOINTING

**SCAFFOLDING
(GREAT BRITAIN) LTD.**
PLANT DIVISION
Mitcham, Surrey
Telephone: MITCHAM 3400 (10 lines)
Telegrams: SCATCO, MITCHAM

Branches at: ABERDEEN
BIRMINGHAM • BOURNEMOUTH
BRIGHTON • BRISTOL • CAMBRIDGE
CARDIFF • DOVER • DUBLIN
DUNDEE • EDINBURGH • EXETER • GLASGOW
HULL • LEEDS • LIVERPOOL • MANCHESTER
NEWCASTLE • NOTTINGHAM • OXFORD • PLYMOUTH
PORTSMOUTH • SOUTHAMPTON • STOKE-ON-TRENT
SWANSEA

*I must always
get my Steel Wheelbarrows
from SGB - they
save me a lot
of money!*

£sd



Reinforced Concrete Turbine House Foundations under construction by Taylor Woodrow.

POWER STATIONS • OIL PIPE LINES • FACTORIES
UNDERGROUND STORAGE TANKS • OPEN CAST COAL

SEA DEFENCE WORKS • RAILWAY SIDINGS
DEEP SEWERS (Tunnel and Open Cut) • AERODROMES

TAYLOR WOODROW

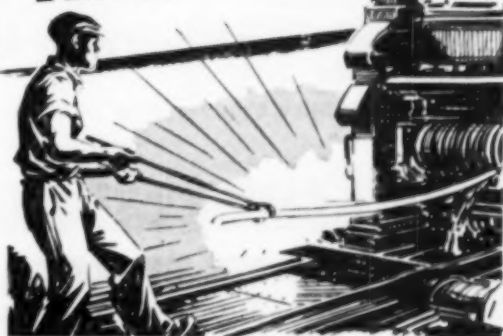
HEAD OFFICE AND WORKS: RUISLIP ROAD, SOUTHALL, MIDDLESEX. PHONE: WANLOW 2366. GRAMS: TAYWOOD, SOUTHALL.
CODE: BENTLEY'S SECOND. LONDON OFFICE: 10 PARK STREET, W.1. PHONE: GROSVENOR 8871.

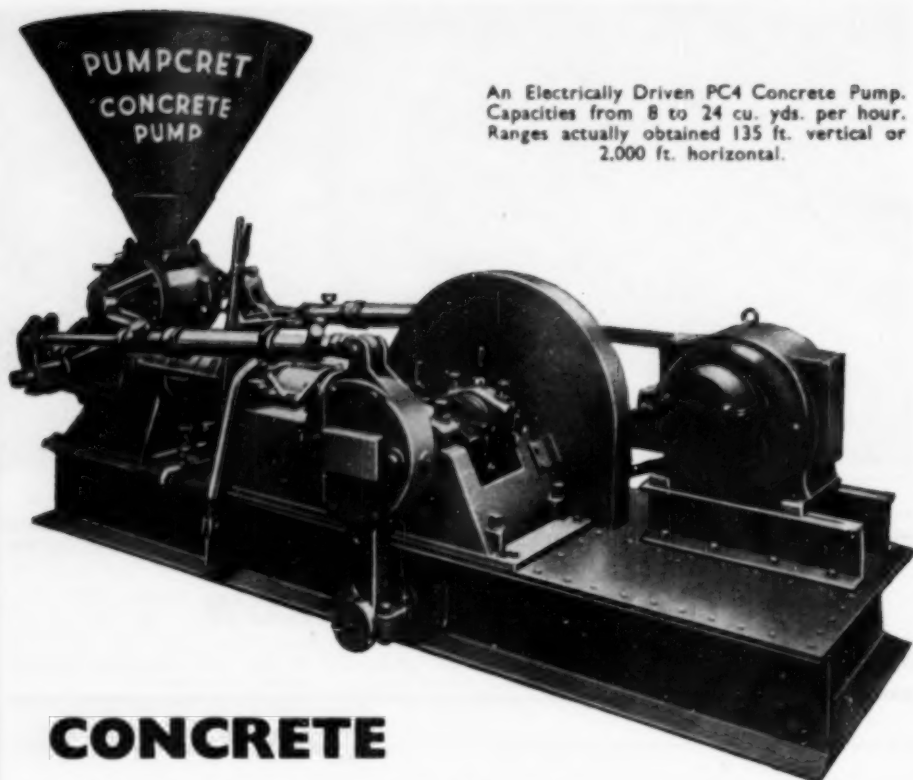
MORE STEEL FOR INDUSTRY

FOR 1953, Britain's record-breaking steelmakers are set the gigantic target of 17,500,000 tons! Everywhere Rawlplug Fixing Devices speed our vast expansion programme—Rawlplugs for screw-fixtures, Rawlbolts for heavy duty fixing, Toggle Bolts for thin and hollow materials and devices for every fixing need. In all materials and conditions Rawlplug Fixing Devices make absolutely firm fixings and save time and labour. Let us advise you on *your* fixing problem.

THE RAWLPLUG COMPANY LTD
CROMWELL RD., LONDON, S.W.7

MORE NEED FOR RAWLPLUG FIXING DEVICES





An Electrically Driven PC4 Concrete Pump.
Capacities from 8 to 24 cu. yds. per hour.
Ranges actually obtained 135 ft. vertical or
2,000 ft. horizontal.

CONCRETE BY PUMP AND PIPELINE


- The latest and most efficient method of placing concrete.
- Pump and Mixing plant can be located where it is most convenient for storing and handling aggregates and cement.
- The concrete is delivered by pipeline just wherever it is required with the minimum of interference with the building operations.
- The speed of the pump governs the whole of the concreting gang.
- Pumpable concrete must of necessity be good concrete.

THE CONCRETE PUMP COMPANY LTD

4 STAFFORD TERRACE, LONDON, W.8

Telephone: Western 3546.

Telegrams: Pumpcret, Kens, London.



**We run our deliveries
to suit the progress
of your job**

In the good old days when steel was plentiful we had to sell Isteg on its merits as a bar. These days its merits are taken for granted and the most important thing about Isteg is the service which stands behind it.

If you design in Isteg you can rely upon it being delivered when and as you need it, carefully bundled and accurately labelled for easy handling on the site. What's more you'll be helping to make more steel available for other urgent needs.

for Concrete Reinforcement

I S T E G

S T E E L

I S T E G S T E E L P R O D U C T S L T D . (S A L E S)
43 UPPER GROSVENOR ST. LONDON W.1. Tel.: GROsvenor 1216
ISTEG is manufactured by Guest Keen & Nettlefolds (Cwmbran) Limited, Cwmbran. McCall & Co. (Sheffield) Ltd., Templeborough, Sheffield. The United Steel Companies Ltd., Sheffield and ISTEG STEEL PRODUCTS LTD.

MOULD OILS & COMPOUNDS

for every process of
concrete production

CONCREAM

This non-staining, smooth and easy working white mould oil can be used with confidence on all classes of in situ and precast concrete work where the use of a white mould oil is recommended.

VIBRAMOL

This non-staining and non-separating mould oil is made specially for use on steel shuttering and moulds where vibrators are used, and provides a good film which is not readily moved under vibration.

SPRAYMOL

This grade of mould oil has been specially produced for use with a spray gun. It can be used with great economy on all types of shuttering and moulds, and will not separate under pressure.

"P.S."

Experience has shown that the production of precast and in situ prestressed concrete needs a special mould compound, and in collaboration with leading prestressed specialists we have produced Grade "P.S." Mould Compound for this class of work.

"8.A."

This Mould Compound has been specially produced to satisfy the requirements of those engaged in the production of spun concrete products.

CONCREAM Regd.
VIBRAMOL Regd.
SPRAYMOL Regd.
"P.S." & "8.A"

PRODUCTS OF THE
ORIGINAL MAKERS OF
CONCRETE MOULD OILS

We specialise in the production of mould oils and compounds for concrete work of every kind, from mass concrete work to high-class architectural stone work, and have an unrivalled experience which enables us to give expert advice on all mould oil problems. We have a grade for every purpose, and will be pleased to submit full details, samples, and prices on request.

RICH^o HUMBLE & SON, LTD., COLUMBA OIL WORKS, LEEDS, 3

Telephone : 27155.

ESTABLISHED 1854

Telegrams : "Columba, Leeds, 3."



THORNTONS FOR REINFORCED CONCRETE CONSTRUCTION

The long list of contracts of all kinds and sizes carried out by us in reinforced concrete reflects the very wide experience we have had in this class of work. We undertake contracts in any part of the country, and invite Engineers and Architects to include our name on their lists for future enquiries.

William

THORNTON & SONS LTD



38 WELLINGTON ROAD
LIVERPOOL 8

REINFORCED CONCRETE ROADS *Cheapest in the long run . . .*



WITH
REINFORCEMENT BY

"Matobar" welded steel fabric reinforcement used at St. Helen's Road, Swansea. Borough Engineer & Surveyor: J. B. Bennett, Esq., M.I.C.E. Contractors: County Borough of Swansea, Borough Engineer and Surveyor's Department.

McCALL'S

McCALL & COMPANY (SHEFFIELD) LIMITED
TEMPLEBOROUGH, SHEFFIELD and at LONDON

CHRISTIANI & NIELSEN LTD

REINFORCED CONCRETE



Reinforced Concrete Office Building for The Shell Co. of Venezuela Ltd., Caracas

54 VICTORIA STREET,

LONDON, S.W.1

TELEPHONE: VICTORIA 6152

GUNITE AND CEMENTATION



Systematic repairs to structures
based on systematic diagnosis of
defects.

WHITLEY MORAN & CO. LTD.

Specialists in the Repair of Engineering Structures

5 OLD HALL STREET, LIVERPOOL.

Telephone: Central 7975

MODERN DRAWING OFFICE Furniture

No finer range of Drawing Office Furniture is available than the Halden range. Every up-to-date refinement making for greater accuracy, greater ease in use, and economy of space has been introduced to the Halden designs. The range includes Drawing Tables, Cabinets, Drawing Boards, Filing Cabinets, size boards

Trestles and Glass Tracing Tables. Large made to customer's own specification. For all office furniture and accessories consult:—



Haldens of Manchester

J. HALDEN & CO., LTD.

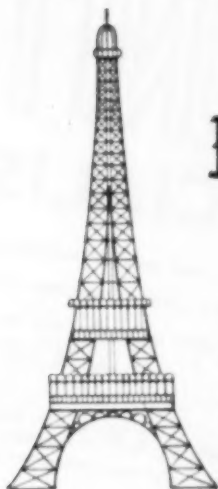
Branches at:—London, Newcastle-on-Tyne,



8, ALBERT SQ., MANCHESTER, 2

Birmingham, Glasgow, Leeds and Bristol.

INSEPARABLE



CONSTRUCTED 1887-89
HEIGHT 985 ft.

EIFFEL *and his* TOWER

To everybody who knows Paris, and to millions who don't, the elegant edifice of the Eiffel Tower is linked for ever with the name of the man who conceived and designed it.

Under the ground, too, as well as above it, civil engineering has some triumphantly paired names. The sober and exactly calculated science of foundation piling is a case in point. Franki has long been a great name in piling throughout Europe and other continents, and in Great Britain this unequalled system of cast-in-situ piling has so dominated the scene that custom has merged two words into one and architects and consulting engineers plan their projects, large and small, on **FRANKIPILES**—the piled foundations which have proved their safety, their speed and their economy.



FRANKI and PILES

**THE FRANKI COMPRESSED PILE
COMPANY LIMITED**

39 VICTORIA STREET, LONDON, S.W.1

Telephone: ABBey 6006-9

Telegrams: FRANKIPILE, SOWEST, LONDON

SOUTH AFRICA: THE FRANKI PILE CO. of S.A. (Pty.) LTD., CAPE TOWN and DURBAN

CONCRETE PROOFING Co. LTD.

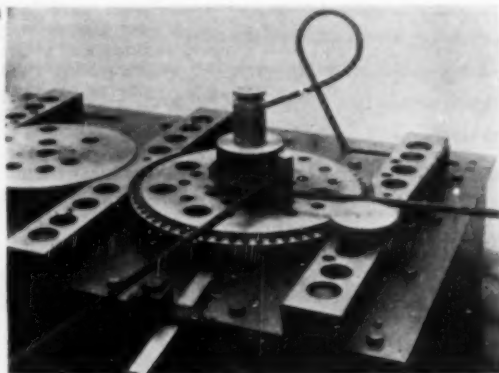
GUNITE SPECIALISTS

Expert advice and schemes submitted for gunite work of every kind. Complete information on the various uses of gunite will be gladly sent on request.

100, Victoria Street, Westminster, S.W.1

Telephone: VICTORIA 7877 and 8278

ARD-50 BAR BENDER



This model is a double disc machine which will bend all diameter bars from $\frac{1}{2}$ in. to 2 in. It is supplied complete with standard accessories, and fitted with an electric motor, petrol engine, or a petrol-paraffin engine. The automatic control is governed by the fluted member (Brit. Pat. No. 469649) which permits the desired bending angle to be set mathematically. It is superior to other types in practical speed, accuracy, simplicity, and economy, and is invaluable for repetition bending. The illustration shows the bending of an angle loop in one operation. The accessories required for this are included in the standard accessories for all machines supplied. We also supply, at extra cost, a special device for bending hoops and spirals, and formers and back rests for special steel, such as "Integ," "Square Grip," "Twistee," etc. This model is in full production for **SALE or HIRE**. We also supply heavier and lighter power bending machines, details of which will be sent on request.

CEMENT & STEEL, LTD. SECOND AVENUE, CHATHAM, KENT

Telephone: Chatham 45580

Telegrams and Cables: Cembelgi, Chatham

CEMENTATION

WILL SEAL WATER LEAKAGES THROUGH CONCRETE, ROCK OR SUB-SOILS, AND WILL STABILIZE SUB-STRATA TO ARREST SETTLEMENT OF STRUCTURES ON FAULTY FOUNDATIONS. ALSO BY THIS PROCESS DETERIORATION OF CONCRETE OR OF MASONRY WORKS CAN BE REMEDIED.

BORED PILES

CAST *in situ* PILES CAN BE PUT DOWN TO GREAT DEPTH WITH A MINIMUM OF HEADROOM AND VERY LITTLE VIBRATION, WITH DESIGNED BEARING CAPACITY.

OUR WIDE EXPERIENCE IS AT YOUR DISPOSAL.

GUNITE

RECONDITIONING DAMAGED AND DEFECTIVE CONCRETE STRUCTURES.
ENCASING STRUCTURAL STEELWORK.
LINING TUNNELS, CULVERTS, RESERVOIRS.
COVERING THE WEARING SURFACES OF CHUTES AND BUNKERS.

THE CEMENTATION
C.O.LTD. Telephone 500 14077-4 BENTLEY WORKS, DONCASTER.

LONDON OFFICE: 39, VICTORIA STREET, S.W.1
TELEPHONE: ABBEY 5726-7-8.



THE "JOHN BULL" CONCRETE BREAKER

NEW "B.A.L." TYPE.

INCREASED :—

PENETRATION, RELIABILITY, LIFE.

REDUCED :—

VIBRATION, NOISE AND WEAR.

THESE ARE THE SALIENT FEATURES
OF THE NEW CONCRETE BREAKER

★ ★ ★

REAVELL & CO., LTD.
RANELAGH WORKS, IPSWICH.

TELEGRAMS: "REAVELL, IPSWICH."

TELEPHONE: 2124



DELIVERED DIRECT TO ANY
CONTRACT BY MOTOR LORRY

Quotations on Application.

Telephone: Paddington 2924 (3 lines).

WASHED
BALLAST, SAND, SHINGLE &
Crushed Aggregate for Reinforced Concrete.

WILLIAM BOYER & SONS, LTD.

Sand and Ballast Specialists,

**IRONGATE WHARF,
PADDINGTON BASIN, W.**
MEMBERS OF B.S. & A.T.A.

AQUAREP

SEND FOR
DETAILS

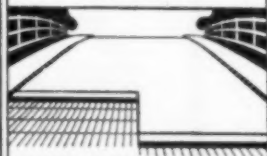
for 100%
WATERPROOF
CONCRETE

DAMP-PROOFING LTD.

DEPTFORD Tel. TIDaway 1486-7 LONDON, S.E.

BRC

FABRIC



FOR ROAD
REINFORCEMENT

GUNITE SPECIALISTS

**W.M. MULCASTER
& CO. (CONTRACTORS) LTD.**

We invite inquiries for Guniting Linings and Renderings
for new or old structures of every kind in any part
of the country.

HASLINGTON

Telephone: Crewe 2615.

CREWE

BATSON

the best-known name in

CONCRETE MOULD OILS

"Releasol"



"Brownol"

Following a recent American test on reinforced concrete, it was
confirmed that Batson's Mould Oil possessed a release
efficiency that ranked first among the top ten lubricants
tested. A trial will convince you too.

JOSEPH BATSON & CO. LTD. SOUTH STAFFORDSHIRE OIL & GREASE WORKS - TIPTON
Telephone: TIPTON 1045. Established 1840.

BLAW KNOX IN WORLD BUILDING AND CONSTRUCTION

Castelo Do Bode Dam

This great engineering project on the River Zezere is part of the Portuguese Government's plan to provide hydro-electric power to feed a grid system for the electrification of railways from Lisbon to Oporto and for industrial development of the Country. The Central Mixing Station was supplied and erected by Blaw Knox and this contribution to a great undertaking is symbolic of the high quality construction equipment and integrity of service offered to engineers in the world-wide effort to build more, build faster and build to last.

BATCHING, MIXING AND BULK CEMENT PLANT · MOTOMIXERS · CONCRETE SPREADERS AND FINISHERS · CONCRETE MIXERS · ROADFORMS
STEEL SHUTTERING · CONCRETE PUMPS · DEWATERING PLANT
EXCAVATORS · EARTH MOVING EQUIPMENT



BLAW KNOX LTD · 11 CLIFTON HOUSE · EUSTON ROAD · LONDON · ENGLAND
BK24

CONCRETE AND CONSTRUCTIONAL ENGINEERING

Volume XLV. No. 8.

LONDON, AUGUST, 1950

EDITORIAL NOTES

The Trials of the Concrete Maker.

"THERE are periods in the growth of science when it is well to turn our attention from its imposing superstructure and to examine carefully its foundations." This sentence is from Professor Karl Pearson's "Grammar of Science" published in 1892. This advice is worth remembering in all branches of science, but it is seldom so opportune as when the word "scientific" is applied to the process of concrete making which, as at present practised, can have no claim whatever to be called scientific. It is a fundamental requirement of a scientific fact that it must be capable of exact repetition, or that nature repeats it exactly. It is a scientific fact that the earth rotates around the sun and so far as we know will continue to do so. It is a mathematical fact that two and two make four, and will continue to make exactly four so long as the words two and four have the same meanings as they have to-day. But whoever has made two or more batches of concrete that all have the same properties? At present this seems to be quite impossible, even in a laboratory, and it is generally necessary to assume that the average strength of three or more samples is the true strength of the material being tested. This lack of uniformity of the strength of concrete is expensive. It is, for example, the reason why 1 : 2 : 4 concrete can, according to the British Standard Code of Practice, be assumed to have a crushing strength of only 3000 lb. a square inch after it has matured for twenty-eight days, although it is quite possible to achieve a crushing strength of more than 10,000 lb. a square inch with the same materials, and in spite of the fact that most of the concrete will have a much higher crushing strength than 3000 lb. per square inch.

On the title-page of the first edition of Professor Pearson's book is printed the motto "*La critique est la vie de la science*". This is a truth that is brought home to the concrete maker in a paper read before the Reinforced Concrete Association, an abstract of which is given elsewhere in this number. The author points out that concrete in ordinary work having an average crushing strength of 5000 lb. per square inch would be likely to range in strength from 7000 lb. to 3000 lb. per square inch—so unscientific is concrete making even when employment is made of all the methods known to-day of obtaining uniformity and when the British Standard Code of Practice requires that the materials used for preliminary cube tests must be measured exactly to one part in one thousand. The results of the preliminary cube tests are so variable, in spite of the very

exact measurement of the ingredients and the attempt to secure uniformity in their manufacture, that three cubes have to be made and tested and the average assumed to be the truth. Such tests may indeed be likened to Pearson's scientific "imposing superstructure" on which is based the strength of concrete which may vary by more than a hundred per cent. however much care goes to its making. The reasons for the impossibility of making the concrete in a structure of uniform strength throughout lie in the nature of the materials and the processes used. It is shown that Portland cement may vary in strength by 50 per cent. or more, particularly if it is obtained from different makers, although the weakest sample will meet the requirements of the British Standard Specification for Portland Cement. Tests on the grading of aggregates, on which the strength of concrete largely depends because it affects the amount of water required to produce a given degree of workability, show enormous variations. For example in the case of various consignments of coarse aggregate delivered to one construction site the proportion which passed a $\frac{3}{4}$ -in. sieve varied from 4 per cent. to 70 per cent., and in the case of sands used in the same work the amount which passed a No. 25 B.S. sieve varied from 30 per cent. to 64 per cent.; these variations in grading would alone result in a difference of 20 per cent. in the strength of the concrete. The effect of moisture in increasing the volume of sand may vary the strength of concrete by 10 per cent., because bulking due to moisture means that, if the sand is damp and is measured by volume, up to 30 per cent. less sand may be used in the concrete compared with occasions when the sand is dry or saturated. It is estimated that by the common methods of measuring by volume the variation in the water-cement ratio may be as much as 15 per cent., with a consequent variation of about 30 per cent. in the crushing strength of the concrete. Examination of a large number of cores cut from concrete roads suggests that different degrees of compaction obtained in actual work may result in a reduction of up to 50 per cent. in the strength of the concrete compared with the strength obtained if the compaction were complete. In the making of test cubes it is estimated that variations in the proportioning, consolidating, and so on may lead to variations up to 30 per cent. in the cube-strength on the basis of which assumptions are made of the strength that will be or is being obtained in the work.

These causes of the variation of the strength of concrete are well-known, but it is well that attention should be drawn to them again and again. There can be few industrial procedures which give more variable results than those in common use in the production of concrete. It is fortunate that the extreme effects of all the factors that can reduce the strength of concrete do not in practice occur at the same time on the same structure. Much has been accomplished in recent years in devising methods by which greater uniformity of concrete will be produced. For example, the author of the paper referred to states that measurement of materials by weight will result in variations of not more than 4 per cent. in the water-cement ratio, and in the best conditions of measurement by volume the variation should not be more than 8 per cent. But obviously much remains to be done if concrete making is to be put on a scientific basis, and revolutionary ideas are wanted.

Square Columns Subjected to Combined Stress.

DESIGN IN ACCORDANCE WITH THE BRITISH STANDARD CODE.

By DONOVAN LEE, B.Sc., M.Inst.C.E., M.I.Mech.E., M.I.Struct.E.,
and OLIVER CUNDALL, B.Sc.(Tech.).

DESIGN charts based on permissible stresses other than those recommended in the British Standard Code of Practice (C.P. 114, 1948), "The Structural Use of Normal Reinforced Concrete in Buildings," may be of little value for use in designs to be made in accordance with this Code. The accompanying charts are applicable to the design of square (and rectangular) columns subjected to axial load only or to a direct load combined with bending. The columns con-

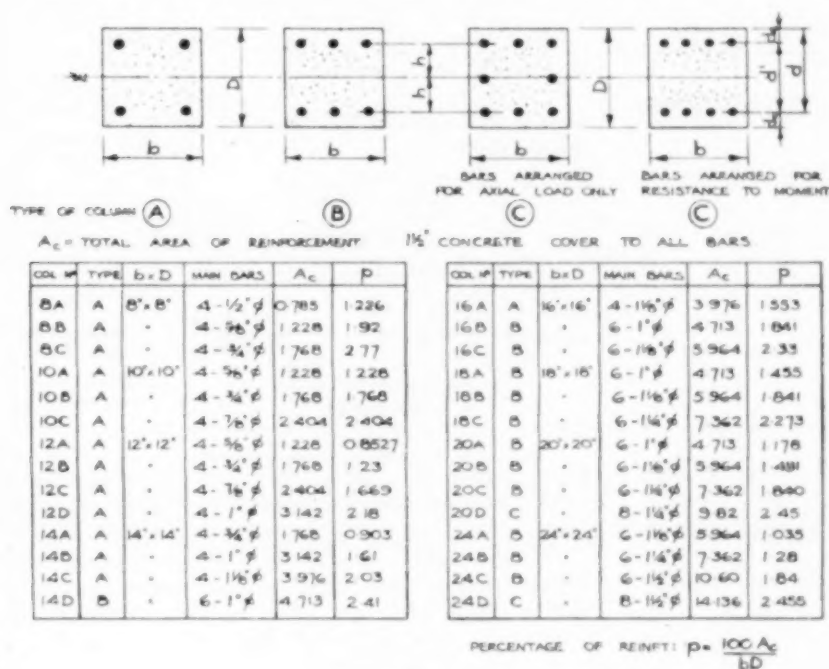


Fig. 1.

sidered are from 8 in. square to 24 in. square and are assumed to be of 1:2:4 concrete (not vibrated) for which the permissible compressive stress is 760 lb. per square inch under axial load only and 1000 lb. per square inch under direct load and bending. Three or four columns of each size are considered, the differences being in the amount of plain round mild steel reinforcement (Fig. 1). Considerations of economy generally favour small proportions of reinforcement, and there is therefore only a limited range of sizes and numbers of bars for each size of column. In the charts the amount of reinforcement is not less than 0.8

per cent. and the maximum about 3 per cent., although the Code permits up to 8 per cent.

Some methods of designing columns subjected simultaneously to direct load and bending assume the distance from the face of the column to the centre of the bars to be a definite proportion of the dimensions of the column, an assumption

POINT ON GRAPHS	STRESSES (LB. PER SQUARE INCH)	FORMULAE BENDING TAKEN ABOUT AXIS OF GREATER MODULUS	m=15	STRESS DISTRIBUTION
POINT A	C = 760 C ₁ = 18,000	P = 760 (bD - A _c) + 18,000 A _c (lb) M = 0		AXIAL LOAD. UNIFORM COMPRESSIVE STRESS C
SECTION 1	C = 1000	$p = \frac{100 A_c}{bD}$ $P = \frac{1000 bD}{1 + 0.14p + \frac{6De}{D^2 + 0.42p(d')^2}} \text{ (lb)}$		+C + C _{max} +C _{min}
POINT B	C = 1000	P = 7000 A _c + 500 bD (lb) $M = Pe \text{ (or } M_1) = \frac{83.3 bD^2 + 3500 A_c (d')^2}{D} (n - lb)$ (GRAPHS I) [(GRAPHS II)]		 [GRAPHS II] e ₁ = e
POINT C	C = 1000	$\eta_1 = 1.0$ $\frac{e}{d} = \frac{\frac{D}{2} - \frac{d}{3} + \frac{0.14 p h d^1}{d}}{d + 0.14 p d^1}$ $p = \frac{100 A_c}{b d}$ $P = 1000 b d \left[\frac{1}{2} + 0.07 p \left(1 - \frac{d}{d^1} \right) \right] \text{ lb}$ GRAPHS I: M = Pe in-lb GRAPHS II: e ₁ = $\frac{M_1}{P}$ in $x = \frac{\left(\frac{p}{100} + 1 \right) d_c - \frac{pD}{200}}{2 + 0.29p}$ PLANE THROUGH CENTRE OF RESISTANCE		 [GRAPHS II] e - e ₁ + x
SECTION 2	C = 1000	$\frac{e}{d} = \frac{-\eta_1^3 + \frac{3\eta_1^2 D}{2d} + 0.9\eta_1 \left(\frac{h}{d} \right)^2 - 0.03\eta_1 \frac{h}{d} \left(\eta_1 - \frac{d_c}{d} \right)}{3\eta_1^2 + 0.9p\eta_1 - 0.45p\frac{D}{d} - 0.03p\left(\eta_1 - \frac{d_c}{d} \right)}$ $P = 1000 b d \left[\frac{\eta_1}{2} + \frac{0.07}{\eta_1} p \left(\eta_1 - \frac{d_c}{d} \right) - \frac{0.075p}{\eta_1} \left(1 - \eta_1 \right) \right] \text{ lb}$ GRAPHS I: M = Pe in-lb GRAPHS II: e ₁ = $\frac{M_1}{P}$ in $x = \frac{\frac{D}{2} \left(\eta_1 - \frac{p}{200} \right) - \frac{\eta_1^2 d}{2} + \frac{p d_c}{200}}{\eta_1 + 0.143p}$		 [GRAPHS I] e - e ₁ + x
POINT D	C = 1000 C ₁ = 18,000	AS SECTION 2 WITH $\eta_1 = 0.454$		 [GRAPHS I] e - e ₁ + x
POINT E	C ₁ = 18,000	P = 0 $\eta_1 = \sqrt{0.021p^2 + p(0.15 + 0.14 \frac{d_c}{d})} - 0.145p$ $M = 9000 A_c (d - y) \text{ in-lb}$ $y = \frac{\frac{\eta_1^2 d}{3} + 0.14 p d_c \left(\eta_1 - \frac{d_c}{d} \right)}{\eta_1^2 + 0.14 p \left(\eta_1 - \frac{d_c}{d} \right)} \text{ in}$		 [GRAPHS II] e - e ₁ + x

Fig. 2.—Formulae.

which is only correct by coincidence. If, as in the charts, the true dimension with relation to the size of the bar and $1\frac{1}{2}$ in. of cover of concrete is used in the calculations a more accurate result is obtained at the expense of other limitations, such as the maximum stress and quality of concrete. The charts, however, enable a square column to suit most ordinary requirements to be selected without calculation when the applied load and moment are known. To conform to the Code the modular ratio is 15 and the formulæ are derived from the basic assumptions given in the Code. The stress in the reinforcement is 18,000 lb. per square inch for columns subjected to axial load (no calculable moment) and does not exceed 18,000 lb. per square inch under combined stress. The charts apply to

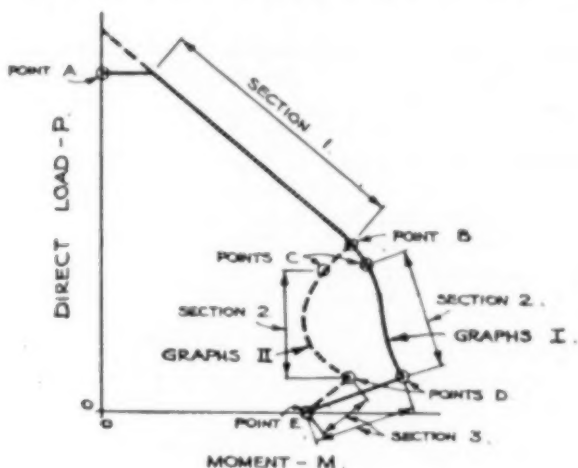
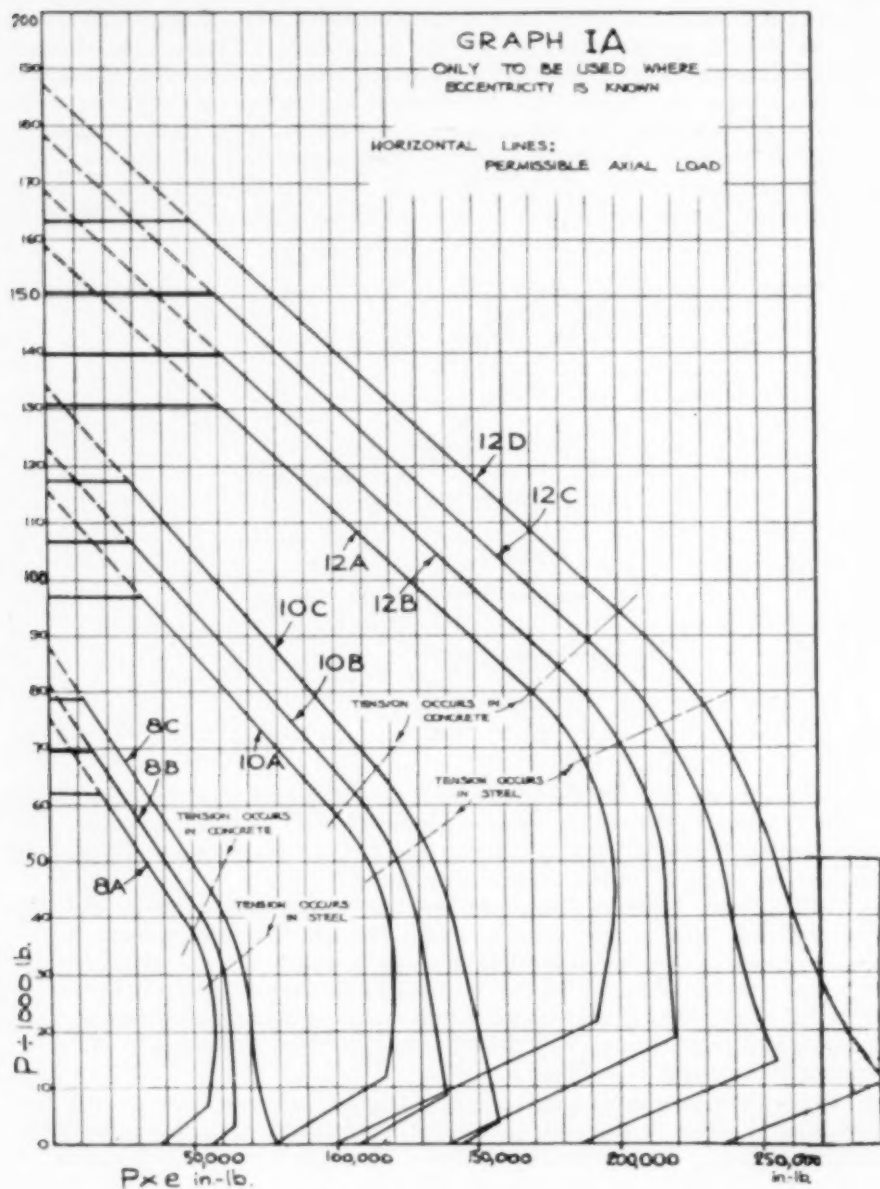


Fig. 3.

"short" columns, and the maximum loads and moments must be reduced for slender or "long" columns in accordance with the rules given in the Code. The charts are applicable only to columns in which 1 : 2 : 4 concrete is used or for a maximum stress of 1000 lb. per square inch.

Although the columns dealt with are square, the charts can be used for rectangular columns by using the curve for the size of square column of the same dimension in the plane of bending as the rectangular column. The moments, loads, and amount of reinforcement are reduced (or increased) in proportion to the width of the rectangular column to the width of the square column. The percentage of reinforcement will be the same as that in the square column, although the amount will differ.

Two series of graphs are given. Graphs I apply to the case when the position of the line of action of the load, that is the eccentricity e from the geometrical centre, is known. Graphs II relate to cases where the moment M and load P are known. The eccentricity e in this case is $\frac{M}{P}$ and is measured from the centre of resistance of the column. For small ratios of M to P when there is no tensile stress in the column, the centre of resistance and the geometrical centre coincide,



Graph 1A.—Columns 8 in. to 12 in. square: Eccentricity known.

and for this condition Graphs I and II are identical. When tensile stresses are present, the two centres are not coincident and, as the ratio of M to P increases, the difference between the curves in Graphs I and II increases, but for large ratios the difference decreases until the curves are again coincident at the point corresponding to bending only ($P = 0$).

Explanation of Graphs.

Each curve on the graphs applies to all conditions from axial load acting alone (no moment) to bending moment acting alone (no direct load). Various conditions affect the analysis of each section of the curves as explained in the following.

GRAPHS I.—DIRECT LOAD AND ECCENTRICITY KNOWN.—Referring to the typical curve (Fig. 3), the stress diagrams, and the formulæ in Fig. 2, the conditions at critical points are:

Point A.—The load P is the greatest axial load which the column can carry with a uniform intensity of stress c of 760 lb. per square inch in the concrete and 18,000 lb. per square inch in the reinforcement. This condition also applies when the moment $M (= Pe)$ is small as shown by the horizontal part of the curve.

Section 1.—The moment combined with the load produce only compressive stresses, the maximum stress in the concrete being 1000 lb. per square inch.

Point B.—There is no stress at one edge of the column; at the opposite edge the stress is 1000 lb. per square inch.

Point C.—There is no stress in the reinforcement near one edge of the column ($n_1 = 1$); the tensile stress in the concrete between this edge and the reinforcement is neglected. At the opposite edge, c is 1000 lb. per square inch.

Section 2.—The neutral axis is above the reinforcement near one edge; this reinforcement is in tension and the stress therein does not exceed 18,000 lb. per square inch. At the opposite edge, c is 1000 lb. per square inch.

Point D.—The stress in the tensile reinforcement is 18,000 lb. per square inch, and the maximum stress in the concrete is 1000 lb. per square inch ($n_1 = 0.454$).

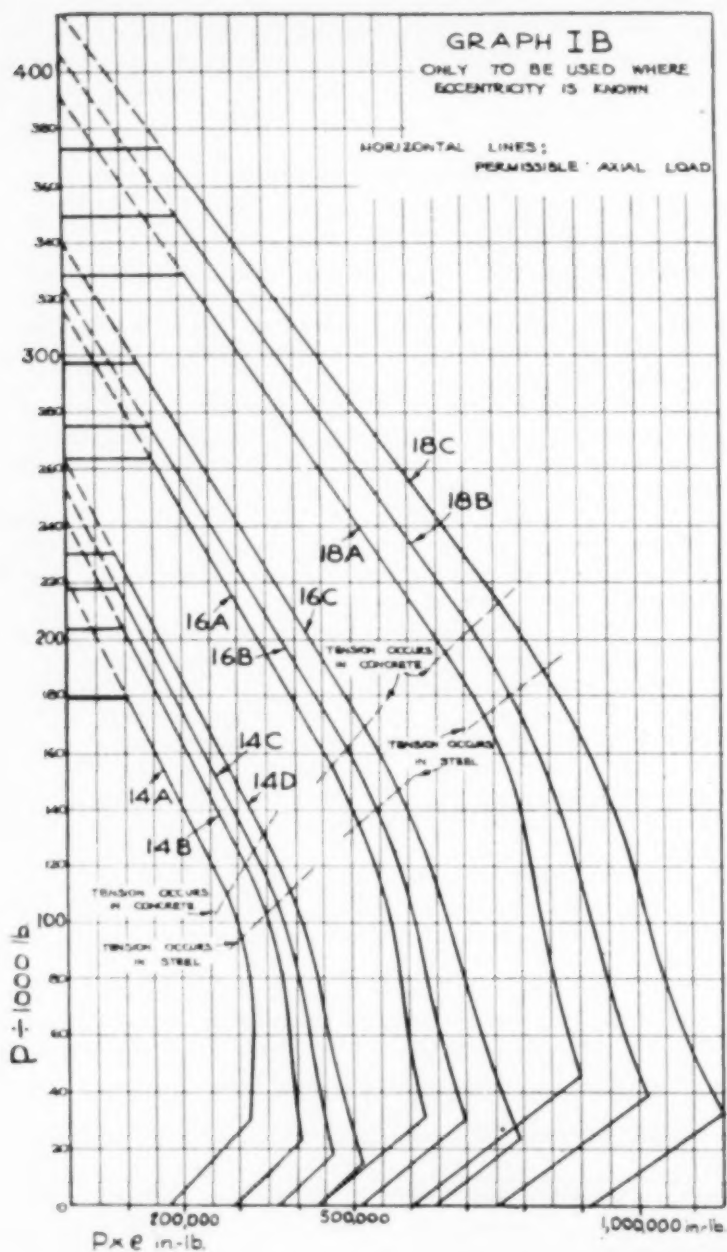
Section 3.—The stress in the tensile reinforcement is 18,000 lb. per square inch, but the maximum stress in the concrete decreases as the load P decreases.

Point E.—This is the limit of Section 3 when there is only pure bending on the column.

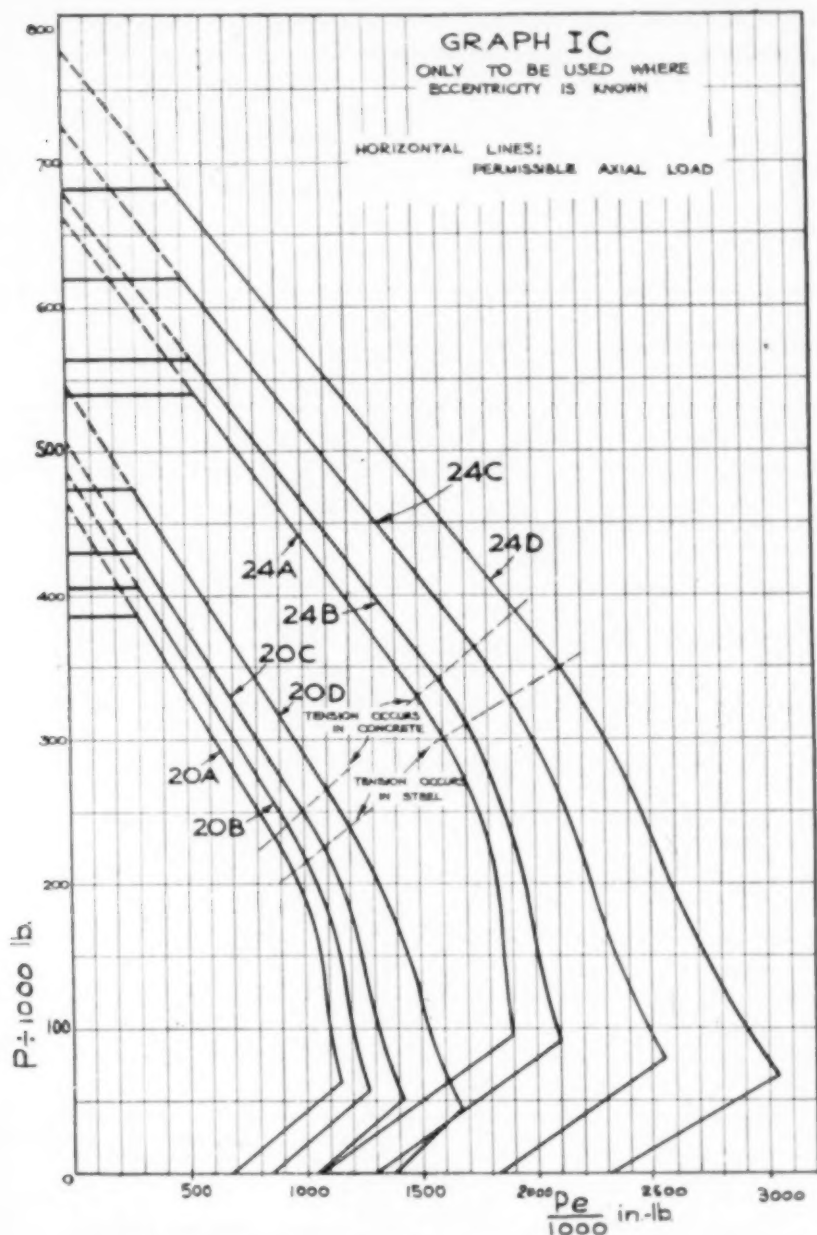
GRAPHS II.—MOMENT AND DIRECT LOAD KNOWN.—This is the case when the load acts at the centre of resistance of the column. The conditions at each of the points and sections are the same as for Graphs I, but the formula (Fig. 3) for Point C and Sections 2 and 3 differs because $e = e_1 + x$ where $e_1 = \frac{M}{P}$ and x is the distance between the geometrical centre and centre of resistance.

Application of Graphs.

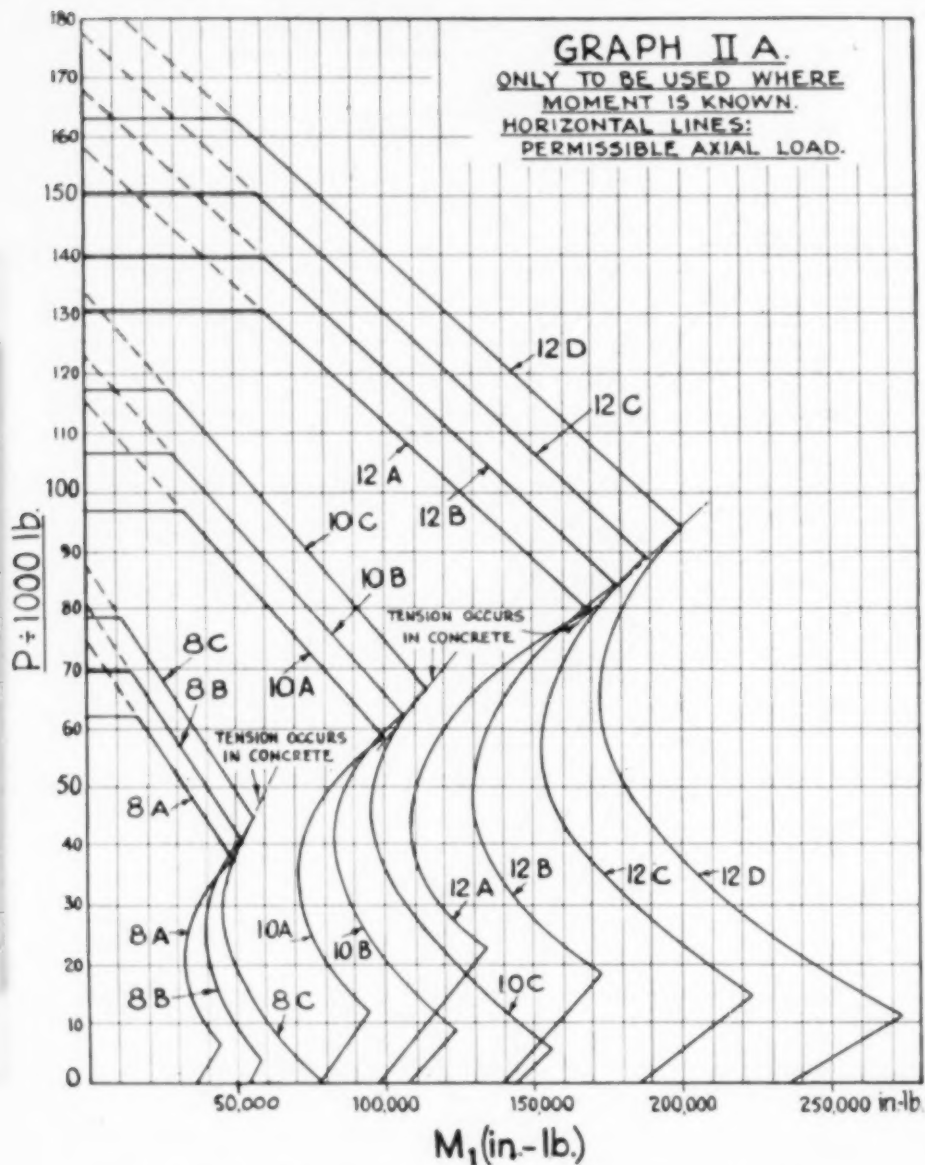
Graphs I apply to columns with connections on the sides for beams (such as brackets carrying precast beams, crane-rail beams, etc.), arches with eccentric thrusts, portal frames with permanent joints at the points of contraflexure, and other columns for which the line of action of the load is known.



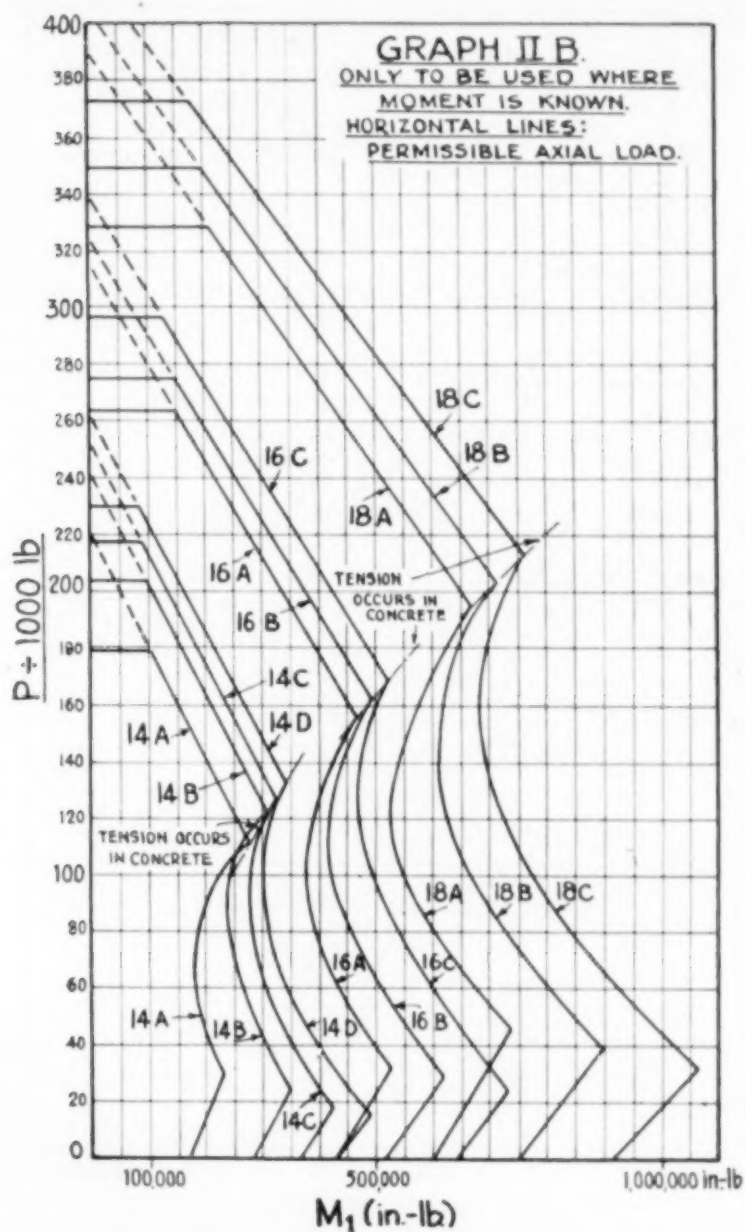
Graph 1B.—Columns 14 in. to 18 in. square: Eccentricity known.



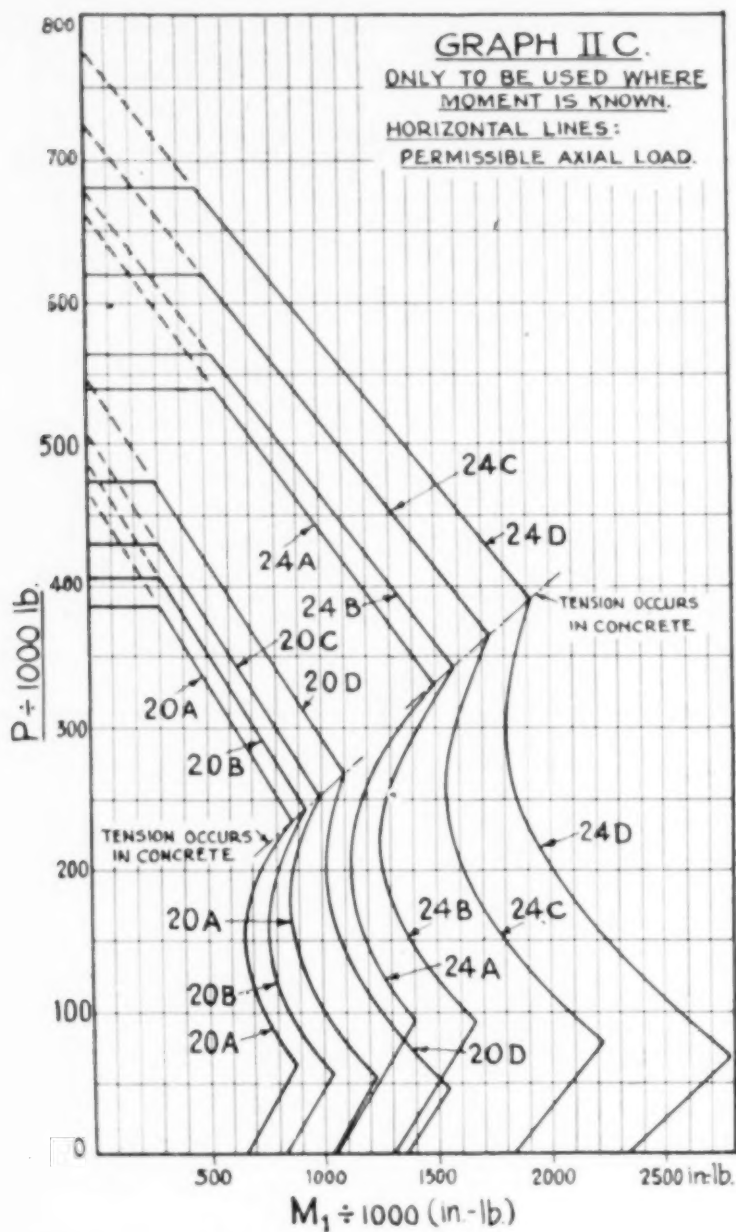
Graph I C.—Columns 20 in. to 24 in. square : Eccentricity known.



Graph II A.—Columns 8 in. to 12 in. square: Moment known.



Graph II B.—Columns 14 in. to 18 in. square : Moment known.



Graph IIC.—Columns 20 in. to 24 in. square: Moment known.

Graphs II apply to the columns of frames and similar structures designed as indeterminate structures for which a moment and a load, acting at an indefinite point, are calculated.

The graphs can be used to select a column to resist a known load P acting at a known eccentricity e , or to resist a known moment M combined with a related load P . Thus if P is known to be 90,000 lb. and e is 2 in.,

$$M = 90,000 \times 2 = 180,000 \text{ in.-lb.}$$

and Graphs I apply. From Graph IA it is seen that a column 12 in. square is required. The reinforcement in column 12B is not quite enough, but that in 12C (four $\frac{3}{4}$ -in. bars according to Fig. 1) is sufficient.

If a column is subjected to a moment M of 600,000 in.-lb. and a load P of 80,000 lb., Graphs II apply, and, from Graph IIB, column 18A (18 in. square; six 1-in. bars) is satisfactory.

The graphs can also be used in the same manner as a check to ascertain whether a column is large enough for its purpose. For example, it is desired to know whether a column 12 in. square reinforced with four $\frac{3}{4}$ -in. bars (column 12A) can resist the combined effect of a moment of 60,000 in.-lb. and a load of 120,000 lb. Curve 12A in Graph IIA applies. Since the intersection of $M = 60,000$ and $P = 120,000$ is to the left of this curve, the column is satisfactory in accordance with the Code.

Concrete as a Protective Barrier for Gamma-Rays.

In the Editorial Notes in this journal for March, 1950, reference was made to research in the U.S.A. relating to the use of concrete as a protective barrier for radiation of gamma-rays. Further research on this subject is reported in the "Journal of Research" of the National Bureau of Standards of the U.S. Department of Commerce, and has special reference to gamma-rays from cobalt-60. It is stated that for effective protection of persons working near a source of radiation of this nature, the thickness of a concrete barrier should be 5 in. if the strength of

the source is 10 millicuries (mc.), 13 $\frac{1}{2}$ in. if 100 mc., 21 $\frac{1}{2}$ if 1000 mc., and 24 in. if 2000 mc. The corresponding thicknesses of a lead barrier are 0.7 in., 2.4 in., 4 in. and 4.5 in. These thicknesses, which are based on broad-beam radiation, assume that the distance from the source to the barrier is 3 ft. 3 in., but less thicknesses are required if the distance is greater. For example, if the distance is 6 ft. 6 in., the corresponding thicknesses are 8 $\frac{1}{2}$ in. (1.4 in.), 16 $\frac{1}{2}$ in. (3 in.), and 19 in. (3.5 in.); the figures in brackets refer to lead barriers.

Coarsely-ground Cement for Experimental Road.

In order to get information on the relative durability of concrete roads in which coarse and fine Portland cements are used, the State Highway Commission of Kansas, U.S.A., is to use coarsely-ground cement for about 18 miles of a new 24-mile concrete road carrying considerable traffic including heavy vehicles. The coarsely-ground cement will be made as nearly as possible to match the Portland cement used in the district thirty years ago, while the remainder will be Type 1

finely-ground cement as made to-day. The experiment is being made as a result of an investigation made in the years 1940 to 1944, when an inspection of 1270 miles of concrete roads showed that those laid before the year 1930 were more satisfactory than those laid since; it was found that the older roads, although cracks had appeared, were sound and more durable. The specifications for the whole of the road are exactly the same except for the fineness of the cement.

Book Reviews.

"Strength and Elasticity of Materials and Theory of Structures." By W. H. Brooks. Volume I. (London: Macdonald & Co. (Publishers) Ltd. 1950. Price 12s. 6d.)

THE sole contents of this small book are described by the subtitle, "Solutions to Examination Questions of the University of London," since it contains fully-worked answers to 111 questions set in the subjects in the internal examination for the degree of Bachelor of Science (Engineering) from 1938 to 1948. In this respect the author is rendering a service to students, as the University no longer publishes model answers. The solutions, which are collected under different headings, are given with little, but useful, comment; one such is the statement that it is presumed from the wording of a particular question that what is required is the stiffness of a member in accordance with the old definition of ratio of deflection to length. None of the questions relates to reinforced concrete.

"Roads: Their Alignment, Layout, and Construction." By K. G. Ratson. 1950. (London: Longmans, Green & Co., Ltd. Price 27s.)

IN his preface, the author states that this book is intended as a guide to the student whose studies include roads. Six chapters on the planning of roads are followed by a short chapter on foundations (mostly laboratory work), 12 pages on road construction, 16 pages on concrete roads, 24 pages on bituminous roads and pavings, 26 pages on private street works (mostly dealing with legal matters), and 8 pages on road bridges.

"Investigations on Building Fires." By T. W. Parker, P. W. Nurse, and G. E. Bessey. (London: H.M. Stationery Office. 1950. Price 9d.)

THIS booklet deals first with methods of estimating the greatest temperature that may have occurred during a fire. The methods are usually based on the effect of high temperatures on certain materials, but warning is given that an inaccurate result may be obtained if the material has been protected temporarily by another, or when the general temperature is estimated by the effect on a material a part of which may have been subjected to a very high local temperature. The second part deals with changes visible in concrete and cement mortar when subjected to high temperature. At certain temperatures—300, 600, 950, and 1200 deg. C.—the changes in colour of concrete

and mortar with siliceous aggregates are sufficiently well defined to enable the temperature to which the material has been subjected to be ascertained. The change to red colour at 300 deg. C. is a useful guide.

"Einflüsse auf Beton und Stahlbeton." By K. Walz, H. Vierheller, and A. Kleinogel. Fifth edition. (Berlin: Wilhelm Ernst & Sohn. 1950. 25 D.M.)

THIS book, in the German language, is in three parts in which, under more than 300 headings, are discussed the effect on concrete of various fluids and solids, and such influences as weather, internal temperature, methods of curing, etc. Special types of concrete, other materials, and methods of construction are described and several proprietary names are explained. The source and author of each entry is given.

"Stählerne Brücken." By G. Schaper. Vol. 1, part 1. Seventh Edition. (Berlin: Wilhelm Ernst & Sohn. 1949. Price 18 D.M.)

ALMOST one half of this book (in the German language) describes very fully the properties, and in less detail the manufacture, of steel. Much of the remainder deals with riveted and welded joints as preliminaries to the consideration, presumably in subsequent volumes, of the design and construction of steel bridges. There is a short description of the types of such bridges and a brief history commencing with the first iron bridge in the world at Ironbridge, Shropshire.

Books Received.

"The Technical Aspect of the Design of Roads." By S. Champion. 1950. (London: Technical Press, Ltd. Price 30s.)

"Publications of the International Association for Bridge and Structural Engineering." Vol. 9. (Zurich: Verlag Leemann. 1950. No price stated.)

"Concrete Shell and Barrel Roofs." Second Edition. (Obtainable free from the Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.)

"Questions and Answers on Concrete Road Construction." (Issued by the Cement and Concrete Association for the Road Research Laboratory of the Department of Industrial and Scientific Research. Obtainable free from the Association, 52 Grosvenor Gardens, London, S.W.1.)

"Building Science." By D. A. G. Reid. Vol. 1. 157 pages. 5 in. by 7½ in. (London: Longmans, Green and Co. 1950. Price 6s.)

"Book-keeping and Accountancy for Private Companies." By Owen J. West. 1950. (London: Jordan & Sons, Ltd. Price 10s. 6d.)

"Bonsusing for Builders." By F. Russon. (Birmingham: Norman Tiptaft Ltd. 1950. Price 10s.)

Slabs Spanning in Two Directions Analysed by Consideration of Pattern of Fractures.

By Professor H. CRAEMER (ALEXANDRIA).

THE application of the plastic theory to the analysis, by consideration of the pattern formed by the fractures, of slabs spanning in two directions is described in the following.

Deformations, and especially changes of curvature, of those parts of a slab in which the stresses are well below the yield stresses can be assumed with sufficient accuracy to be exceedingly small compared with the deformations of those parts where fractures occur. The fragments between the lines of fracture may for practical purposes therefore be considered to be planes, and lines of fracture are consequently straight. These assumptions are confirmed by tests showing

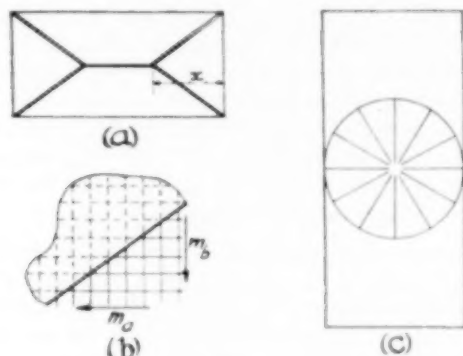


Fig. 1.

the behaviour of rectangular slabs carrying uniformly-distributed loads, the fracture diagrams being as shown in *Fig. 1a*. Only in such cases as circular slabs or where concentrated loads occur are the fragments of a fractured slab exceedingly small, in which cases a network of cracks as shown in *Fig. 1c* results. Reinforcement crossing the lines of fracture is assumed to be subjected to the same stress throughout, the stress being the yield-point stress. Where reinforcement crosses a line of fracture at right-angles the line forms the axis of rotation of the fracture moment, which is constant along the line of fracture because the same stress occurs throughout. This simplifies the calculations. Where, however, a line of fracture is crossed obliquely by reinforcement bars, the axes of rotation are at right-angles to the bars, as indicated by the vector arrows in *Fig. 1b*, in which case the components m_a and m_b of the fracture moment are constant along the line of fracture. Since the moment along the lines of fracture is the greatest moment, there are no shearing forces at the fractures, except in some cases where several fractures intersect or where a free edge is met obliquely by a line of fracture.

Where the pattern of the fracture is known, the fracture moment is best

determined by imparting to the system a virtual displacement so that the fragments remain plane and rotate against each other along the lines of the fracture without causing relative displacements, that is if the system is displaced as actually happens at failure. Internal work A_i is then performed by the fracture moments alone. The sum of the internal work and the work A_e performed by the external load is zero, that is $A_i + A_e = 0$, an expression which can be evaluated since the fracture moment is included in A_i .

If the fracture diagram (Fig. 1a) contains one or more unknown elements x_1, x_2, \dots, x_n , the form of the equation for the fracture moment is $m = f(x_1, x_2, \dots, x_n)$, the correct solution being that in which m is greatest. Therefore

$$\frac{\partial m}{\partial x_1} = \frac{\partial m}{\partial x_2} = \dots = \frac{\partial m}{\partial x_n} = 0 \quad (1)$$

This method can be demonstrated by applying it to problems which can be solved only laboriously by the theory of elasticity or are insoluble by that theory.

Let slab ABCD (Fig. 2a), which is loaded with a uniformly-distributed load p , be rigidly fixed along AB and AD and unsupported along BC and CD. The slab is reinforced in the bottom and top in two directions. The reinforcement in the bottom and top parallel to AB is that required to resist fracture moments of m_a and m_a' respectively along AD. For the reinforcement parallel to AD the corresponding moments are m_b and m_b' along AB. The four moments are required to satisfy any arbitrary proportions, such as $m_a : m_a' : m_b : m_b' = 1 : 3 : 1 : 2$, or

$$m_a = m_b, m_a' = 3m_a, m_b' = 2m_a. \quad (2)$$

If m_a is known, the remaining moments and the amount of reinforcement can be calculated. A probable fracture may be along AE across which a positive moment occurs while negative moments occur along AB and AD. The distance DE ($= x$) is not known. The load on fragment ADE is $1.0 xp$. If unit virtual displacement downwards is imparted to point E, the centre of gravity of the load is moved a distance of one-third, and the external work performed is $\frac{xp}{3}$. Fragment ABCE can be divided into two parts AFE and BCEF, the loads on which are $1xp$ and $2(3-x)p$ respectively, the displacements of the centres of gravity being one-third and one-half. Therefore the total work performed by the external forces is given by

$$A_e = \frac{xp}{3} + \frac{xp}{3} + \frac{2(3-x)}{2}p = \left(3 - \frac{x}{3}\right)p.$$

Fragment AED rotates about axis AD to an angle of $\frac{1}{x}$, and moments m_a and m_a' alone perform internal work, the resultant of which is $2(m_a + m_a')$. The work performed is $-\frac{2(m_a + m_a')}{x}$. Similarly fragment ABCE rotates about AB to an angle of $\frac{1}{x}$ and the resultant of the moments is $xm_b + 3m_b'$. The internal work performed is $-\frac{xm_b + 3m_b'}{2}$. The total internal work A_i is

$$-\frac{2(m_a + m_a')}{x} - \frac{xm_b + 3m_b'}{2}$$

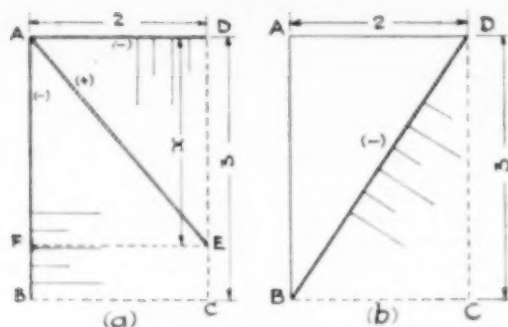


Fig. 2.

Having regard to equations (2),

$$A_i = - \left(\frac{8}{x} + \frac{x+6}{2} \right) m_a.$$

Since $A_i + A_e = 0$,

$$m_a = \frac{18x - 2x^2}{48 + 18x + 3x^2} p. \quad (3)$$

It follows from equation (1) that

$$(18 - 4x)(48 + 18x + 3x^2) - (18x - 2x^2)(18 + 6x) = 0,$$

the solution of which is $x = 2.22$. Therefore $m_a = m_b = 0.293p$; $m_a' = 0.88p$ and $m_b' = 0.585p$.

Another probable fracture diagram is that in Fig. 2b wherein the free corner C rotates with a negative moment about the fracture BD. The load on fragment BCD is $3p$, and, with unit virtual displacement of C downwards, the centre of gravity of the load is moved by one-third, therefore $A_e = p$. The components of the fracture moment along BD are $2m_a'$ and $3m_b'$. The rotation of the fragment about BD can be considered in two parts, namely a rotation to an angle of one-third about axis AD and a rotation to one-half about axis AB, the interior work performed therefore being

$$A_i = - \left(\frac{2}{3} m_a' + \frac{3}{2} m_b' \right).$$

Having regard to equations (2), $A_i = -5m_a$. Substituting in $A_i + A_e = 0$ and reducing, $m_a = 0.2p$, which is a smaller moment than that calculated on the assumption shown in Fig. 2a; therefore in this example the fracture in Fig. 2b will not occur.

If it is assumed that the fracture in Fig. 2a is at 45 deg., $x = 2$, and, substituting in (3), $m_a = 0.2915p$. The foregoing shows that if a reasonable fracture diagram is assumed the moments can be calculated fairly accurately without having to consider the condition represented by equations (1) to obtain the maximum values.

A problem which can hardly be solved by other methods is that of a triangular slab (Fig. 3) fixed along sides AB and BC, and unsupported along AC. Assume that the slab carries a load P uniformly distributed along AC. Reinforcement

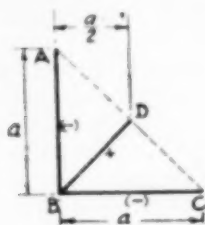


Fig. 3.

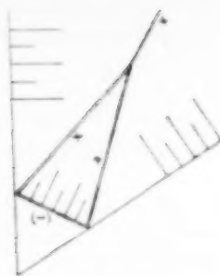


Fig. 4.

is provided in the top and bottom so that the positive and negative fracture moments m are equal. Due to symmetry, a fracture diagram as in Fig. 3 applies. If unit virtual displacement downwards is imparted to D, the centres of gravity of the loads $\frac{P}{2}$ on each of the two fragments ABD and CBD is lowered by $\frac{1}{2}$, so that

$A_s = \frac{P}{2}$. The resultant of the positive moments along the fracture line BD, considering fragment BCD, is $0.5 am$, rotating about BC. The fracture along BC contributes a moment of am in the same sense, giving a total of $1.5 am$. The fragment rotates about BC at an angle $\frac{2}{a}$, so that the internal work performed is $-3m$ or, for both fragments, $A_i = -6m$. Equating internal and external work, $m = \frac{P}{12}$. Therefore the fracture moment is independent of the span.

In slabs of this nature, fracture may also occur in a system of forked lines as in Fig. 4. A square slab fixed along four edges and carrying a uniformly-distributed load produces, in this manner, a fracture moment which is about 10 per cent. greater, but the effect is less for rectangular slabs, and non-existent for freely supported slabs. For slabs with acute angles, and for slabs carrying concentrated loads, diagrams with forked fractures give higher fracture moments than if a simple fracture pattern is assumed.

Consideration of the lines of fracture of reinforced concrete slabs is also given by K. W. Johansen in the final report of the third congress of the International Association for Bridge and Structural Engineering.

Reinforced Concrete Residential Flats at Pimlico, London.

ON a riverside site at Pimlico, London, eleven blocks of residential flats are in course of construction for the Westminster City Council. Block No. 1 (*Fig. 1*) is now occupied, Nos. 2 and 5 are almost complete, and No. 6 is in course of construction. Construction of blocks Nos. 7, 8, 9, and 10 started recently but work has not yet commenced on Nos. 11, 12, and 14. Blocks 1, 2, 5, and 6, which are described in this article, are of reinforced

423 ft. long as it extends over a "way-through" as shown in the longitudinal section in *Fig. 2*, which also shows typical cross sections and plans of Block No. 1. (See pages 286 and 287 for *Fig. 2*.)

Figs. 3 and *4* show typical details of some of the reinforcement and *Fig. 5* to *Fig. 10* show various stages of the construction. The external walls are faced with blue bricks up to the sills of the windows of the ground floor story and



Fig. 1.—Rear Elevation of Block No. 1.

The small building in the foreground is a refuse-collecting shed.

concrete construction; each comprises nine stories, a basement, and cylindrical tank rooms above the roof. Block No. 7 will be seven stories high and is a reinforced concrete frame structure. Nos. 8, 9, and 10 will be each four stories high and constructed with load-bearing brick walls and reinforced concrete floors.

The reinforced concrete structure of Blocks Nos. 1, 2, 5, and 6 comprises load-bearing walls, wall-columns, and solid floor and roof slabs. The story-height is 9 ft. 4 in. (floor to floor) and the width is about 30 ft. Block No. 2 is 282 ft. long, and Nos. 5 and 6 are each 340 ft. long, but block No. 1 is

with yellow bricks above. A strip of concrete 4 in. deep is exposed to form the face of a nib above each line of windows carrying the brick skin and windows. The concrete is also exposed on the outer face of the walls of the top story, which is set back, and the tank rooms, on the piers and slabs of the "way-through", and on the faces of the upstand beams of the balconies and on the flanks and back walls of the recessed balconies. Where the exposed concrete is painted it is coated with an enamel which has a chlorinated rubber base producing a glazed surface which can be washed.

The buildings are designed for the loads

and wind pressures recommended in British Standard Code of Practice CP 3, Chapter V, Loading. The stresses and design of the reinforced concrete work are in accordance with British Standard Code CP 114 (1948). The proportions of the structural concrete are generally

The slumps vary from 1 in. upwards, the maximum slumps specified being 3 in. for slabs and 4 in. for walls. The concrete is consolidated by immersion vibrators.

For block No. 5 the concrete was distributed from the mixer to the point of

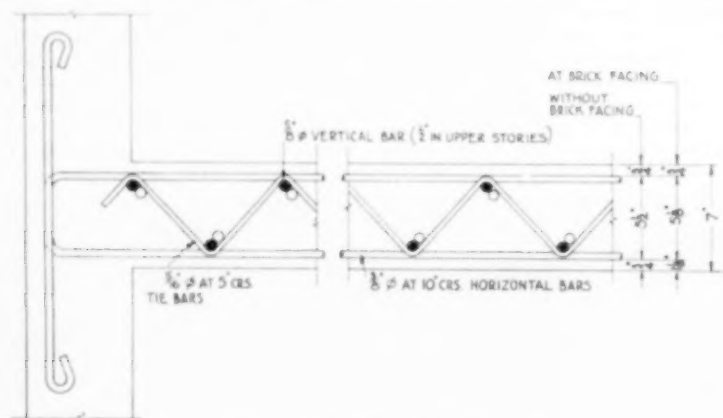


Fig. 3.—Details of Walls.

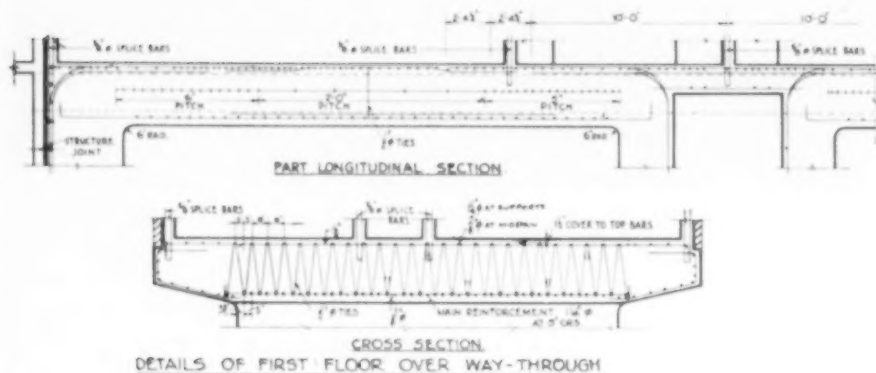


Fig. 4.

1:1.8:3.6 using ordinary Portland cement, crushed gravel, and washed pit-sand. The crushing strengths specified are 2200 lb. per square inch at seven days or 3300 lb. per square inch at 28 days. Cubes are tested at seven days, and at 28 days only if the strength at seven days is not sufficient. Generally the strengths at seven days are from 2500 lb. to 4000 lb. per square inch.

placing by a pump, but for the other blocks the concrete is discharged from the mixer into bottom-opening skips which are lifted by derrick cranes. The cranes (Fig. 6) travel on short tracks between the blocks and have jibs 120 ft. long, and are also used to lift the panels of shuttering and skeletons of reinforcement. The average rate of progress of each block is about one story a month.

Construction of the first block commenced in August, 1948.

Foundations and Basement.

The foundations, which are of plain concrete, bear on ballast which underlies filling and clay at a depth of about 15 ft. The load on the ballast does not exceed 4 tons per square foot. Walls and piers of plain concrete extend from the ballast to within 3 ft. 2 in. of the lowest part of the basement floor (*Fig. 2*), and at the level of the top of the foundation walls 3 in. of plain concrete are spread over the site. Waterproofing is laid on the plain concrete and a reinforced concrete

of concrete is generally not less than $\frac{3}{4}$ in., but where there is a brick facing the cover is not less than 1 $\frac{1}{4}$ in., allowance being made for the provision of thin metal slots that are embedded in the concrete and in which metal bonds, projecting horizontally into the joints of the brickwork, are inserted as the bricks are laid. The brickwork is built after completion of the concrete walls and is supported on the 4-in. nib, which projects 5 in. from the wall.

The shuttering for the faces of walls to which brickwork is to be attached is of steel plates (*Fig. 9*) in panels, each of which is the height of one story, and

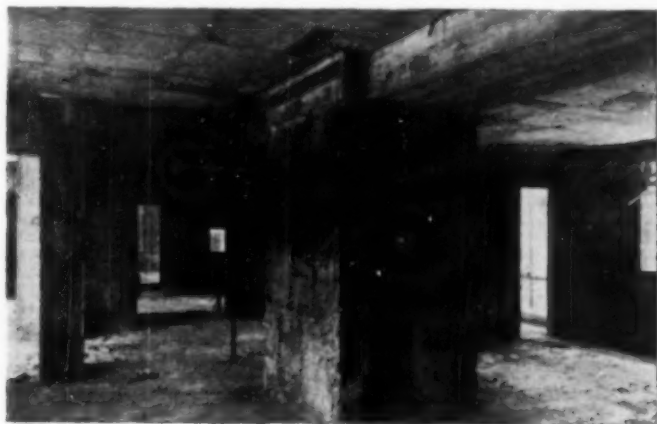


Fig. 5.—Concrete before Application of Finishes.

slab overlies the waterproofing which is carried up the outside of the basement walls to waterproof completely the work below ground. The basement floor, which is not connected to the walls, is a 5-in. concrete slab, laid to fall, carried on hardcore deposited on the lower reinforced concrete slab.

Walls.

The reinforced concrete walls above the ground floor are generally 7 in. thick and are lined on the inside with 1-in. wood-wool slabs. The reinforcement in the walls (*Figs. 3 and 10*) is a layer of vertical and horizontal bars near each face, the two layers being maintained in position by $\frac{1}{8}$ -in. diagonal tie-bars. The cover

stiffened by a framework of steel scaffold-tubes. Upon removal of the shuttering the outside face of the concrete is coated by bituminous waterproofing applied by spray. The shuttering for the inner face is provided by the wood-wool slabs which are supported by a timber frame and steel scaffold-tubes. Raking tubes secured to steel-wire loops built into the floor slabs hold the inner shuttering in position. The shuttering for the faces of concrete walls and wall-columns, which are not lined with wood-wool or faced with brickwork, but which are to be rendered, is treated with a liquid to retard the setting of the cement on the face so that a key can be formed for the rendering (*Fig. 5*).

The reinforced concrete walls of the cylindrical tank rooms on the roofs of

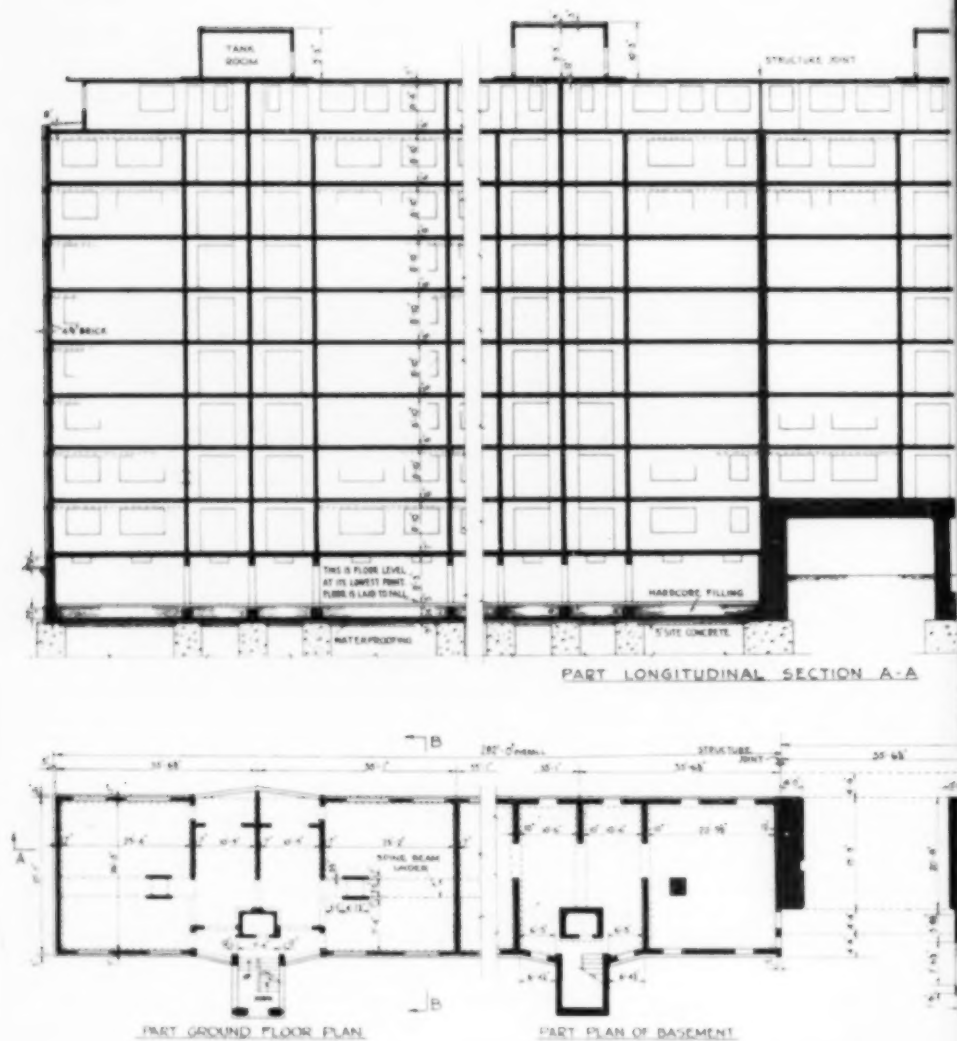
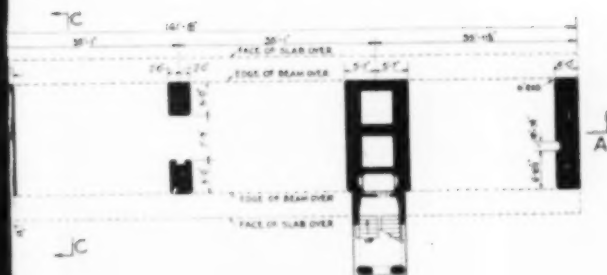
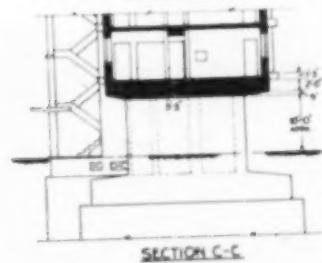
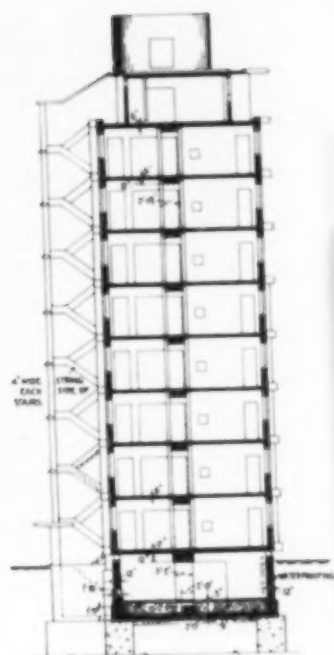
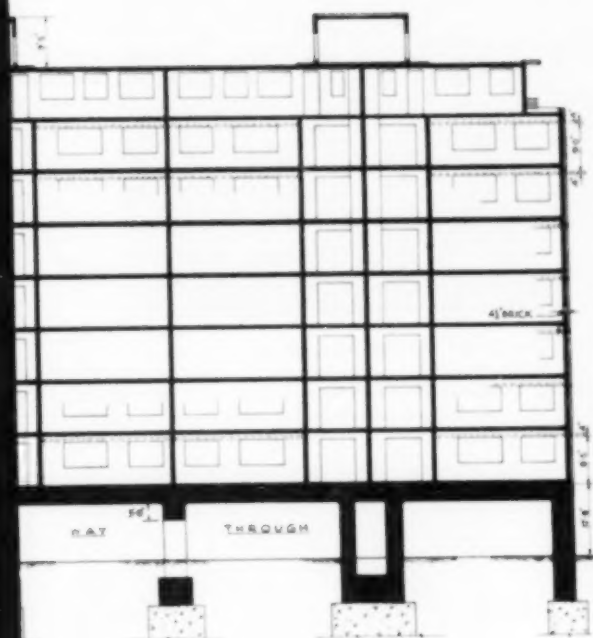


Fig. 2.—Reinforced Concrete F



PLAN OF WAY-THROUGH

Pimlico, London : Block No. 1.



Fig. 6.—Arrangement of Travelling Derrick Cranes, Block No. 2.

each block are 5 in. thick and the internal diameter of the tank rooms is 17 ft.

Floors.

The floors generally are 6-in. reinforced concrete slabs spanning transversely between the outer longitudinal walls and a longitudinal spine beam about 3 ft. wide and projecting 12 in. below the bottom of the slab. Longitudinal partition walls forming a central corridor are in line with the sides of this beam, the existence of which is not therefore evident in the rooms or corridors. The

shuttering for the soffits of the floor slabs are metal plates supported on adjustable steel props. A length of about 50 ft. of floor of the full width of the block is concreted in one operation, rebated construction joints, either straight across the floor or zig-zagged, being formed at the end of each day's work. The covering

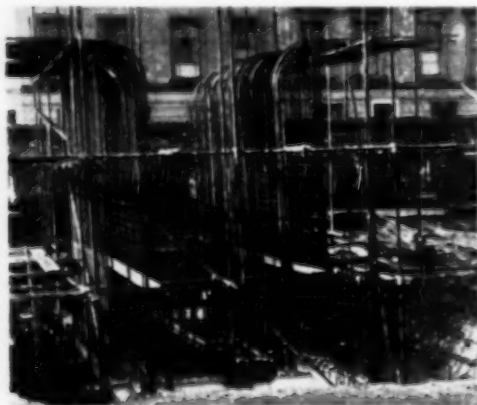


Fig. 7.—Reinforcement in Piers of Way-Through.



Fig. 8.—Supports for Staircase.

of the floors is generally wooden boards on sound-insulating pads. Where floors are covered with a composition finish, a layer of glass-wool is provided between the structural concrete and the screeding, the total thickness of the covering being about 3 in.

Timber shuttering lined with pressed grainless board or sheets of aluminium is used for the cast-in-situ reinforced concrete stairs (Fig. 8).

The extension of block No. 1 necessitates that the first floor should span about 30 ft. to provide a "way-through" at ground level. The slab of the first floor is therefore 3 ft. 3 in. thick and is heavily reinforced (Fig. 4), and is designed to act monolithically with the supporting piers. The compressive reinforcement is retained by $\frac{1}{2}$ -in. lacing ties which are at 24-in. centres near the middle of the span and at 5-in. or 6-in. centres near the supports. The extension is separated completely from the main part of block No. 1 by a structure joint across which



Fig. 9.—Shuttering for Walls.

August, 1950.

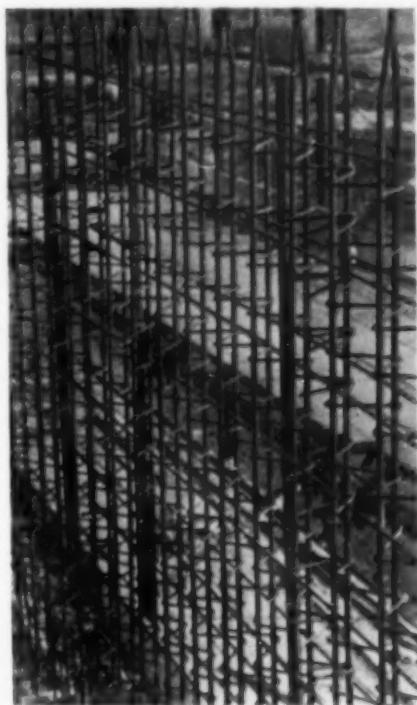


Fig. 10.—Reinforcement for Load-carrying Walls.

flexible copper sealing-strips are provided. There are no other expansion or contraction joints elsewhere in the buildings. The vertical reinforcement in the piers is bent over to project into the first-floor slab. The overhanging bars were temporarily supported on steel scaffolding (Fig. 7).

Ducts for District Heating.

Hot water is to be supplied to the flats from the power station at Battersea on the opposite side of the river Thames. The water flows and returns in 12-in. steel pipes which pass under the river in a tunnel constructed about 1880 and used by the Metropolitan Water Board. On both sides of the river the pipes are brought to the surface up old shafts about 80 ft. deep, but from the top of the shaft to the site the pipes are in a new underground reinforced concrete duct about 700 ft. long.

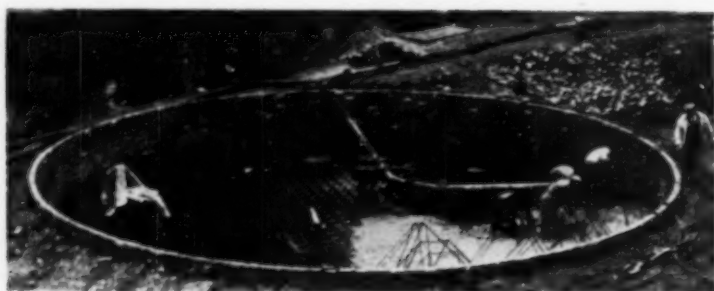


Fig. 11.—Foundation of Tower.

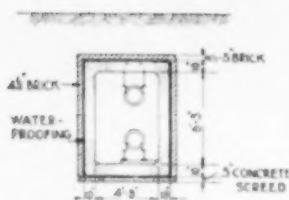


Fig. 12.—Typical Section through District-Heating Duct.

From the shaft the duct proceeds under Grosvenor Road parallel to the river for a distance of about 340 ft. from the shaft and at Antrobus Street turns northwards, passes under a water main, and emerges into the disused Belgrave dock. At the inner end of the dock the duct passes below new workshop buildings to the new pumphouse from which the pipes proceed to an accumulator tank. The steel tank contains 2300 tons of water (up to 200 deg. F.), and is built in a steel tower with glass panels, 35 ft. diameter and 126 ft. high. The lower part of the tower for a height of 30 ft. is encased in a reinforced concrete wall the outer face of which is lined with granite setts. The foundation of the tower is a reinforced concrete raft, circular in plan, seen in course of construction in Fig. 11.

The duct (Fig. 12) is rectangular in cross section and is 4 ft. 3 in. wide and 6 ft. 3 in. high inside. The walls and bottom and top slabs are 10 in. thick. The level of the top of the duct is from

3 ft. to 9 ft. below the surface, and as the ground is waterlogged it was necessary to provide cofferdams during the construction, which was on the cut-and-cover principle. The trench was therefore lined with temporary sheet-steel piling driven down to clay, but timbering was used near water-mains because the vibration due to piling would have been detrimental to the mains. Before the reinforced concrete slabs and walls of the duct were constructed, a layer of lean concrete 3 in. thick was deposited in the bottom of the trench the sides of which were lined with 4½-in. brick. A bituminous waterproof layer extends over the lean concrete and the inner faces of the brick lining which forms permanent shuttering for the outer faces of the walls. The inner faces and the underside of the top slab were shuttered with steel plates. The waterproof layer is carried over the top of the duct, where it is protected with a 3-in. layer of bricks. In the old dock the duct was constructed in the open. Plain 1 : 5 : 10 concrete was deposited on the gravel at the bottom of the dock up to the level of the underside of the duct. The duct is buried in the earth filling of the dock.

The architects for the scheme are Messrs. Powell and Moya. The structural consulting engineers are Messrs. Scott & Wilson. The consulting engineer for the district heating is Mr. S. B. Donkin. The contractors for blocks Nos. 1, 2, 5, and 6 and for the culvert in connection with the district heating are Messrs. Holloway Brothers (London), Ltd. The contractors for blocks Nos. 7 to 12 and 14 are Messrs. Rowley Bros.

Construction with Moving Forms.—VI.*

By L. E. HUNTER, M.Sc., A.M.Inst.C.E.

Reinforcement.

DESIGN.—The reinforcement must be designed with the requirements of moving-form construction in view, and it must be as simple as possible. Vertical bars must be as few as possible. Fig. 34 is a plan of some of the walls of a grain silo with rectangular bins of different sizes. At each intersection of walls there are stirrups at the same regular spacing as the horizontal bars in the walls, and therefore indicate the correct spacing for the horizontal reinforcement. In this

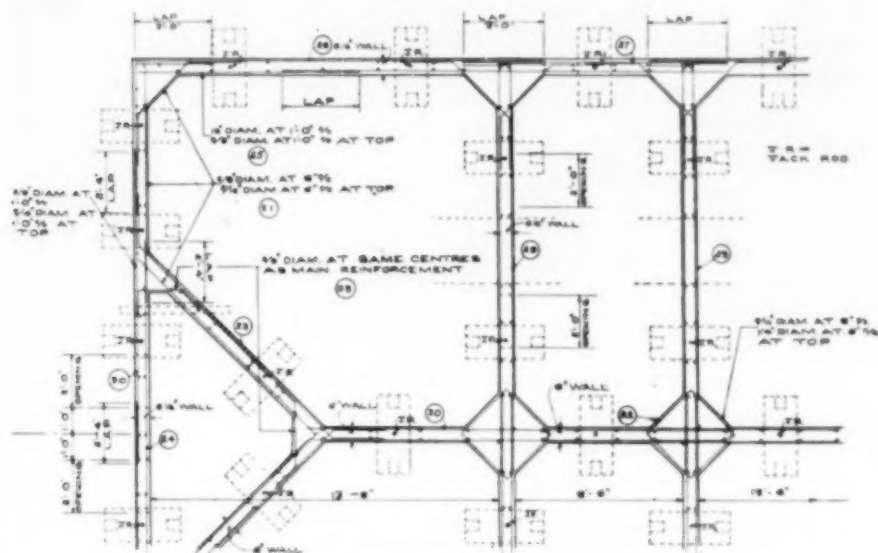


Fig. 34.—Reinforcement in Rectangular Bins.

case some vertical bars are provided in the walls. In a circular bin the horizontal bars in the wall are placed generally in the middle of the wall.

Generally, bars of less than $\frac{3}{8}$ -in. diameter are not used, especially if there are no vertical bars, as small bars sag and it is preferable to use bars $\frac{1}{2}$ in. or more in diameter at wider spacing. Despite the use of bars of reasonably large diameter, it is sometimes found that in long walls it is advisable to provide some vertical bars to prevent sagging of the horizontal bars. It may happen, especially in circular bins, that a bar will "spring" after the guide has risen above it; most probably the bar will spring to the face of the wall, and it is difficult to adjust the bar even in the relatively new concrete beneath the bottom of the forms. Vertical bars assist in keeping the horizontal bars in position and prevent sagging.

The provision of hooks at the ends of the bars may be a source of trouble,

* Continued from July, 1950.

especially if the bars turn and the hooks protrude from the wall. In straight walls it is common to provide an extra length of bar for the development of bond. Additional overlapping bars can be provided for this purpose if the length of the wall is too short to accommodate the longer bars. It is usual, however, to provide hooks at the ends of the main bars in circular walls.



Fig. 35.—Racks for Storing Reinforcement.

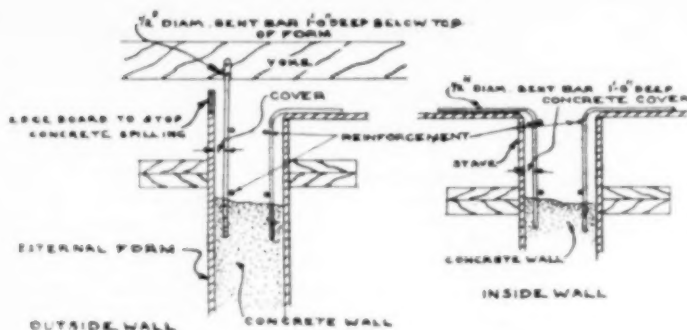


Fig. 36.—Providing Required Cover of Concrete.

STACKING REINFORCEMENT ON THE DECK.—For stacking the reinforcement, it is an advantage to have horizontal racks on top of the yokes on which to place sufficient bars for one day's work; this ensures that the runways are kept free for the concrete barrows. An arrangement of racks is shown in Fig. 35.

COVER OF CONCRETE.—The minimum cover of concrete over the reinforcement in moving form construction should, in the writer's opinion, be 1 in. Less cover is very difficult to maintain in a wall, and if a watertight structure is required on an exposed site it is better to have 1½ in. of cover. If the cover



Fig. 37.—Typical Schedule of Reinforcement.

is too small rust may soon stain and disfigure the walls. In the case of a structure 100 ft. or more in height, the penetrating power of wind-swept rain is far greater than at ground level. The advantage of moving-form construction in eliminating joints is lost if the reinforcement is not adequately covered. The provision of horizontal links at the intersection of walls helps in placing correctly the main horizontal bars, but if the reinforcement is too complicated there will be a tendency for the reinforcement to be lifted as the forms are raised.

The reinforcement has to be fixed with the minimum of tying, otherwise this operation retards the work. It is necessary to maintain the required cover of concrete, one method of achieving this being to provide steel-pin guides bent down from the top of the forms, the distance from the outside of the pin to the inner face of the form being equal to the required cover as on the left-hand side of *Fig. 36*. The pins are generally about 1 ft. 3 in. long. The reinforcement

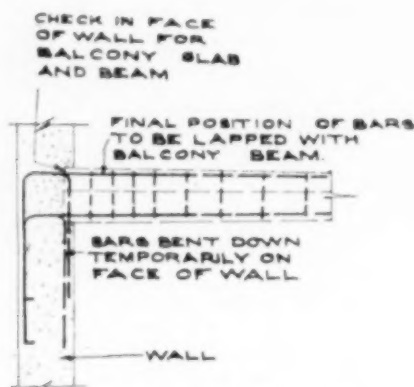


Fig. 38.—Arrangement of Reinforcement at Projections from Wall.

is placed at the top of the forms as they rise, and is guided into position; by the time the initial set of the concrete has taken place the reinforcement is firmly fixed in the correct place. An alternative method of providing the correct cover by the use of steel guides is shown on the right-hand side of *Fig. 36*.

BAR SCHEDULES.—Great care must be taken to follow the drawings when placing the reinforcement. The employment of first-class steel-fixers is essential, as the work requires expedition and care and the ability to work by memory. To facilitate fixing, it is advantageous for diagrams to be made so that the steel fixing is shown at a glance. *Fig. 37* shows typical notes and tables for this purpose, and includes a key plan, schedules of bent and straight bars in the walls and intersections of the walls, and the spacing of the horizontal bars in the walls and intersections. *Fig. 37* also shows the number and weight of horizontal bars in one course (or layer) in the walls. In the walls of the structure for which these schedules were prepared there were no vertical bars except at the intersections.

SLABS PROJECTING FROM WALLS.—It may be necessary to begin moving the forms at a level lower than that at which some projecting feature occurs; for

example, a cantilevered balcony may project from the wall of the main structure and in this case it is essential for the bars in the balcony to be embedded downwards into the wall or pilaster. Fig. 38 shows how this can be achieved. Bars for the balcony are placed correctly in the wall or pilaster, but the projecting part of the bars is bent downwards along the face of the forms. When the moving forms have passed these bars, the bars are bent up in their correct position. If dowel-bars are provided to project from the wall or pilaster and to lap with the main bars in the balcony, it is an advantage if the two sets of bars are welded together.

In the case of suspended floors, the floor reinforcement cannot extend into the walls, but dowel-bars must be provided the outer ends of which are temporarily bent horizontally or vertically against the forms. After the forms have passed the level of the slab, the dowel-bars are straightened and the floor reinforcement placed in position to overlap with them.

Fixing Flat-bottom Rails to Concrete Sleepers.

In a proposal by Professor Hartmann for fixing flat-bottom rails to reinforced concrete sleepers (described in "Der Eisenbahnbau" and reproduced in a recent number of "Betonstein-Zeitung"), direct connection between the rail and sleeper is avoided, because the transmission of forces through small areas subjected to great intensities of pressure is unsuitable for a plastic material, such as concrete, when dynamically loaded. The rails rest in a groove between two lugs on the sleepers (Fig. 1), the space between the rail and the outer lug being packed with hardwood. In the other space two steel wedges are drawn together and tightened by a bolt (Fig. 2) passing through them and thereby securing the rail against lateral movement. An undercut in the outer lug prevents vertical movement. A layer of poplar wood provides a cushion below the bottom flange of the rail and between the steel wedges and the con-

crete. There are no holes in the concrete to produce weakness of the sleepers.

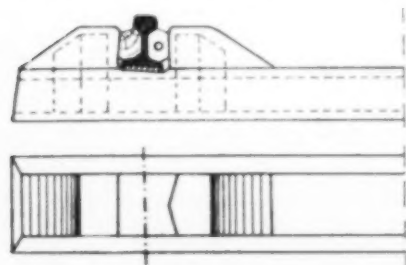


Fig. 1.

E—August, 1950.

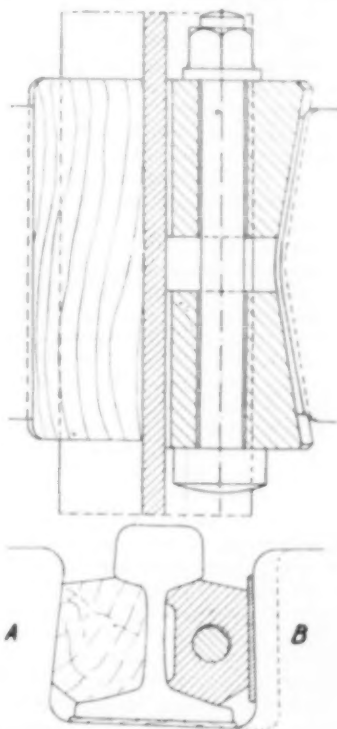


Fig. 2.—Cross Section and Sectional Plan on AB.

A Test of a Prestressed Concrete Railway Bridge Girder.

A PRESTRESSED concrete beam of 43-ft. 6-in. span, and identical in design with those incorporated in an under-line bridge at Normanby Park steelworks of Messrs. John Lysaght, Ltd., was tested to destruction recently. The bridge comprises fourteen precast prestressed concrete beams laid side by side and each 48 ft. long and weighing about $5\frac{1}{2}$ tons. Concrete cast in situ between and over the beams is lightly reinforced. The only shuttering required on the site was on the four vertical faces of the bridge. All the beams were placed in position in one day. It is believed that these are the longest precast prestressed beams in the country.

The purpose of the test (Fig. 1), which was carried out by Mr. R. H. Harry Stanger at Elstree, was to determine whether the assumptions of the design regarding safety against cracking, co-operation between the precast beams and the in-situ concrete, and safety against failure were correct.

The dimensions of the beam and the arrangement of the load are shown in Fig. 2. The calculated stresses at various stages of loading are shown in Fig. 3. The measured deflection, the dead and live loads for which the beam was designed, and the maximum widths of cracks are shown in Fig. 2. In the bottom of the beam there were 64 wires and in the top 16 wires of 0.2 in. diameter and having a tensile strength of 100 tons per square inch. The precast beam was steam-cured for five days after casting, and the stretching force of 4700 lb. per wire (equal to a stress of 150,000 lb. per square inch) was released five days after casting. The change of strain upon release was measured at two places and, from these observations and the stress-strain diagram of the wires, the calculated reduction of prestress due to the elastic contraction of the concrete was 11,700 lb. per square inch, that is, about 8 per cent. of the initial prestress. The maximum stress in the concrete was 2610 lb. per square inch. The average strength of concrete cubes was 6400 lb. per square inch.

The in-situ concrete was cast around the precast beam when the latter was

sixteen days old. The composite beam, the weight of which was 9.7 tons, was loaded up to 40 tons when the in-situ concrete was 13 days old and had a cube-strength of 3700 lb. per square inch. The moduli of rupture of two prisms of the precast concrete, 4 in. square by 24 in. long, were 830 lb. and 1030 lb. per square inch. Measurements made on prisms subjected to conditions similar to those of the beam showed that no reduction of prestress due to shrinkage occurred.

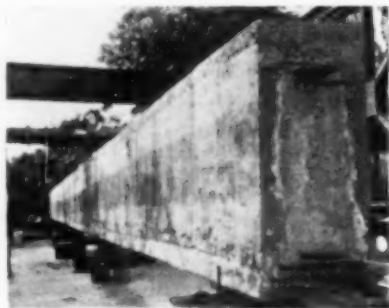


Fig. 1.—Beam under Test.

The loss due to creep is estimated to be 200 lb. per square inch, that is about $7\frac{1}{2}$ per cent. of the stress in the concrete at the time of release. With this assumption the modulus of rupture of the precast concrete was 1000 lb. per square inch, which is likely to be accurate within ± 10 per cent.

The beam was loaded in increments of 4 tons. During the first loading, the first cracks, having a maximum width of 0.003 in., appeared when the load was 32 tons, but from the load-deflection diagram the actual cracking-load can be assumed to be 20 tons, compared with the design load of 9.2 tons. When the cast in-situ concrete was 25 days old, the beam was loaded for the second and third times. At this time the average cube-strength of the precast concrete was 7480 lb. per square inch and of the in-situ concrete 4150 lb. per square inch. The prism-strengths were 6520 lb. and 3105 lb. per square inch respectively.

At the second loading, during which the load was again increased by increments of 4 tons, no cracks 0.003 in. wide became visible at 20 tons. According to calculation cracks were expected at about 17 tons. The load was then increased to 28 tons when the maximum width of crack was 0.008 in. and the deflection 1.655 in. After unloading, the deflection was 0.003 in.

loading. The load of 42 tons (third loading) was maintained for forty-nine minutes, during which period the beam continued to deflect.

At 43 tons the beam began to yield as a whole. The load was further increased to 44 tons, which caused the beam to fail gradually. Failure (Fig. 4) which occurred near one of the loading points and was apparent by the crushing of the

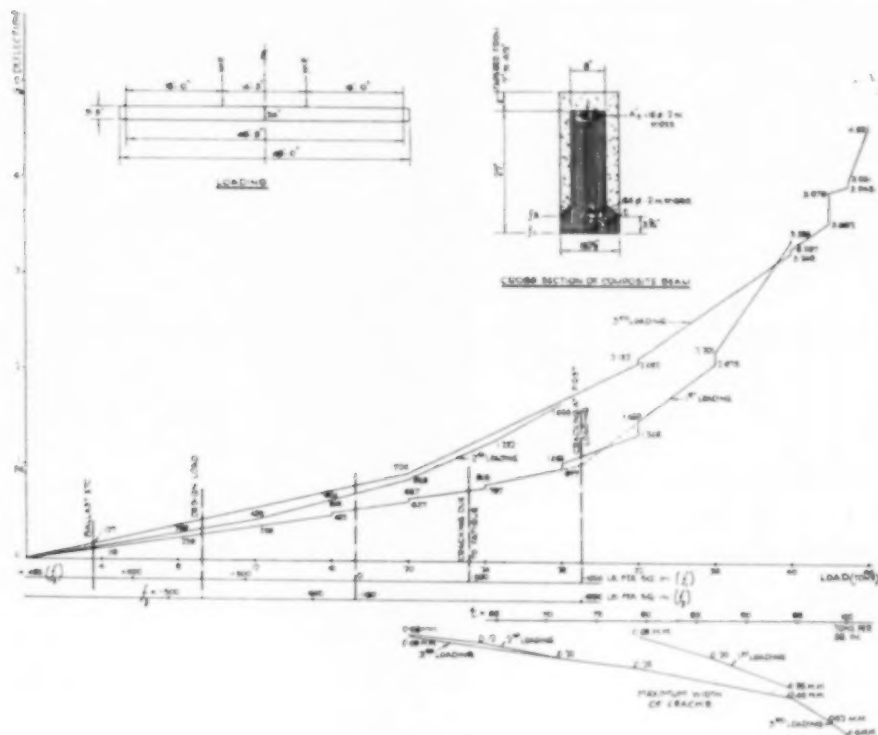


Fig. 2.—Details of the Test.

At the third loading, the load was increased to 20 tons, to 32 tons, and to 40 tons, and was then increased by increments of 1 ton. The deflection at 40 tons was slightly less than that under the same load at the first loading, but this was probably due to the fact that, at the first loading, 40 tons was reached in 3 hours 39 minutes, while at the third loading it was reached in 1 hour 15 minutes. Consequently the effect of creep was much greater at the first

in-situ concrete at the top of the beam, was due to excessive elongation of the wires in the bottom. The stress in the wires was then about the guaranteed minimum tensile strength of 100 tons per square inch. Upon further increase of the deflection at a reduced load, a horizontal crack (*Fig. 4*) appeared at the top of the precast part of the beam, but this was a secondary failure occurring after the in-situ concrete was crushed. No damage was done to the concrete in

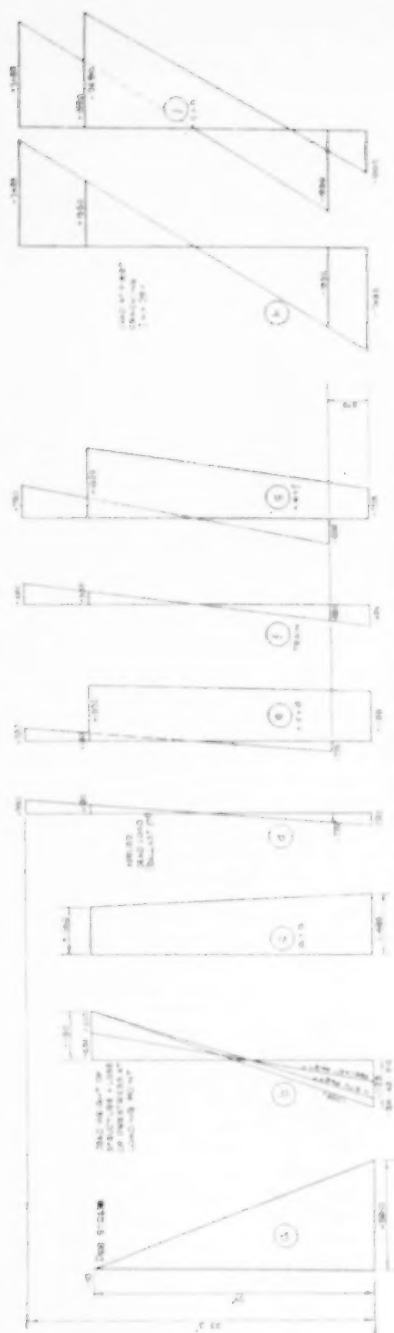


Fig. 3.—Stress Distribution at Various Stages.

the precast part of the beam. The beam was still capable of carrying a substantial load.

Measurements of the strain of the concrete and the wires, made during the first and third loading, indicate that at an early stage of the loading the neutral axis was at the mid-depth of the beam and that it moved gradually upwards as the load increased. At 40 tons the depth to the neutral axis was 13 in. at the first loading and 12 in. at the third loading. At 43 tons the depth was 11 in. The greatest strain measured was 0.0019 which means that the concrete was in a plastic state down to about 5 in. from the top. At the top of the precast beam the strain was 0.00065, and below this level the precast beam contributed more to the compressive resistance than the in-situ concrete because of its much greater strength. It is therefore a close approximation to assume a rectangular distribution of stress on a depth of 11 in. The lever arm was therefore $33.3 - 3.3 - 5.5 = 24.5$ in. The maximum bending moment at failure was 120,000 ft.-lb. due to dead load and 788,000 ft.-lb. due to the applied load, the total bending moment being 908,000 ft.-lb. Therefore the total tensile force, which equalled the total compressive force, was

$$908,000 \times 12 = 445,000 \text{ lb., of which the}$$

$$24.5$$

two $\frac{3}{4}$ -in. bars provided in the in-situ concrete resisted about $0.22 \times 40,000$, say, 8800 lb. The contribution of the prestressed wires, with a cross-sectional area of 0.5 sq. in. and placed 3 in. above the neutral axis, where the measured strain was 0.0004, amounted to about $0.5 \times 28 \times 10^6 \times 0.0004 = 5600$ lb. The stress in the concrete was therefore about

$$13.5 \times 11$$

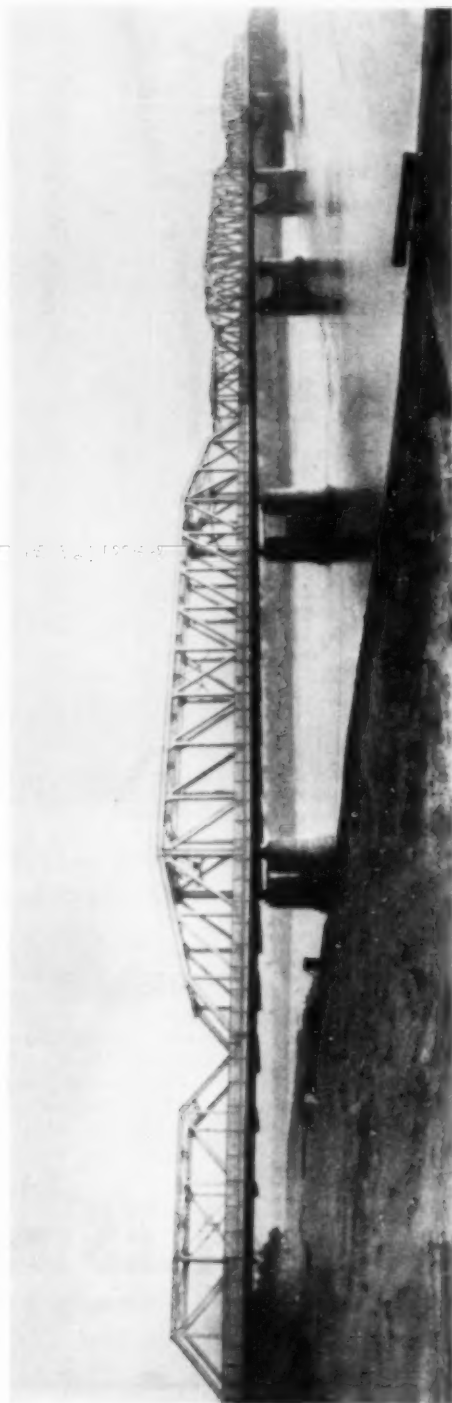
square inch, which was about 93 per cent. of the prism-strength of the top in-situ concrete. The stress in the wires was

$$\frac{445,000}{2.01} = 222,000 \text{ lb. per square inch.}$$

The stresses in the wires given in Fig. 3 are based on the assumption that the depth to the neutral axis was 13 in., as ascertained at a load of 40 tons at the first loading.

The conclusions drawn from the test are that the modulus of rupture of the precast concrete was calculated, with

August, 1950.



4150

RAIL AND ROAD BRIDGE OVER THE RIVER TIGRIS AT BAGHDAD

for the Iraqi State Railways

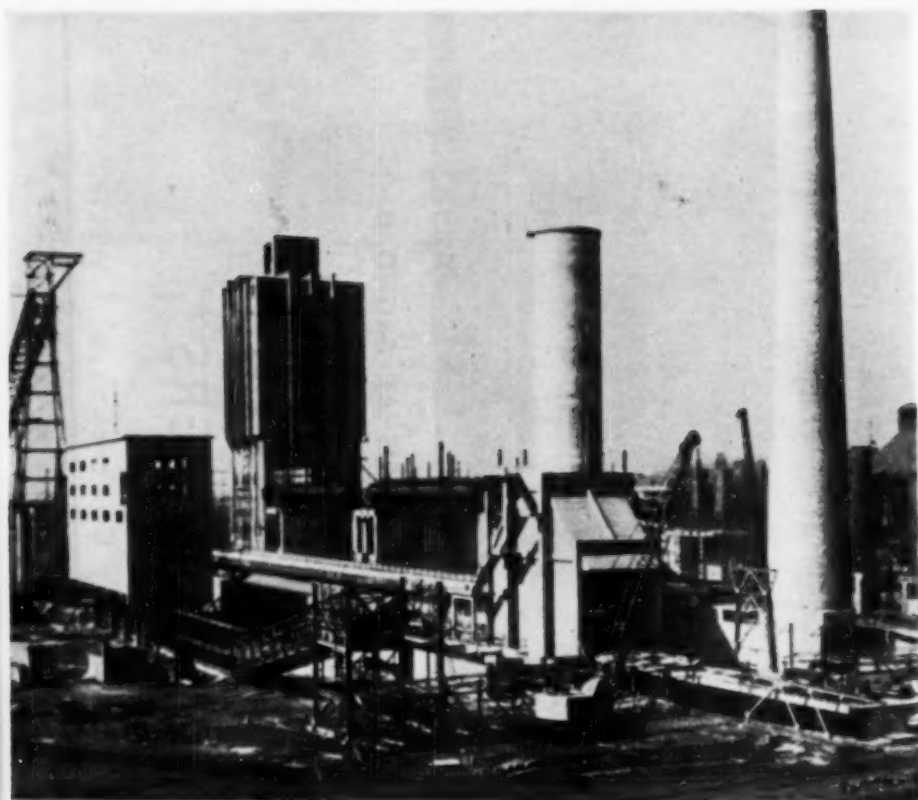
Consulting Engineers: COODE, VAUGHAN-LEE, FRANK & GWYTHER

(Previous Bridge Contracts in Iraq included the King Feisal and King Ghazi Bridges at Baghdad, the Diyala Bridge, and Railway Bridges over the Lesser Zab and Euphrates Rivers)

HOLLOWAY BROTHERS

(LONDON) LIMITED

MILLBANK *Building and Civil Engineering Contractors* WESTMINSTER



A general view of the new coking plant at the East Greenwich Gasworks, designed and constructed by Messrs. Simon-Carves, Ltd., for the South Eastern Gas Board. All the structures shown are supported on Simplex Concrete Cast-in-Situ Piles.

SIMPLEX CONCRETE PILES LTD.

25 BRECHIN PLACE,

SOUTH KENSINGTON,

LONDON, S.W.7

Telephone: Fremantle 0035-6

close approximation, to be 1000 lb. per square inch. Although at first loading 92 per cent. of the ultimate bending moment at the third loading was applied, the beam completely recovered and cracking at the second loading occurred at a load at which, by calculation, there was no longer any precompression in the concrete. The beam made a complete

The test shows that the ultimate load of composite prestressed beams with bonded wires can be predicted very closely from the tensile strength of the wires and the prism-strength of the in-situ concrete, in this case the average compressive stress in the concrete being 93 per cent. of the prism strength.

Although the dead weight of the struc-

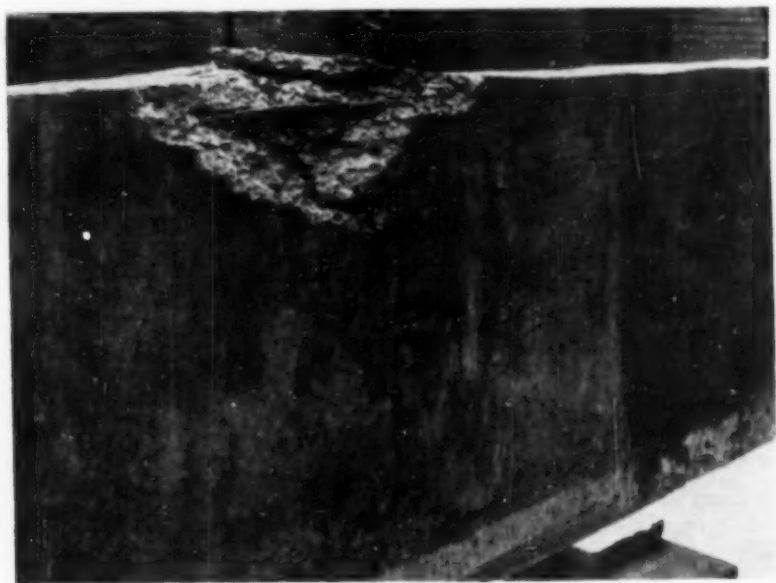


Fig. 4.—Beam after Failure.

recovery after the second loading. Although the calculated tensile stresses in the in-situ concrete were large, no cracks could be seen in this part before cracking occurred in the precast beam. There was no change in the width of cracks at the junction of the precast and in-situ concrete. Full co-operation between the precast prestressed and in-situ concrete was obtained by thoroughly roughening the surface of the precast beam without having to provide protruding links.

At failure the guaranteed minimum tensile strength of the wire was attained.

ture was originally carried solely by the precast beam, it was transferred to the composite structure before failure. After failure the beam was still capable of carrying a substantial load, and upon removal of this load most of the deflection disappeared and cracks between the supports and the loading points completely closed.

The beam was designed by Twistee Reinforcement, Ltd., and was precast by Messrs. Costain Concrete Co., Ltd. The in-situ concrete was cast on the beam at the testing works.

Variables in Concrete Making.

In our Editorial Note are mentioned some of the points made by Mr. F. N. Sparkes, M.Sc., M.Inst.C.E., in a paper entitled "Control of Variations in Quality of Concrete and its Effect on Mix Proportions," presented to the Reinforced Concrete Association. The paper is given in full in the "Reinforced Concrete Review," October, 1949, and an abstract of the author's recommendations for controlling some of the variable factors in the making of concrete is given in the following.

Cement.—So far as the cement is concerned, the engineer can do little to improve its uniformity. This is a matter for the cement manufacturers, and one can rest assured that if greater uniformity could have been economically achieved the necessary action would already have been taken. It is possible that cement made at any particular works may be more uniform than is indicated by some test results, but there are no published data to show by how much the uniformity may be improved. At present it is doubtful whether the manufacturers could consider such a possibility, but with the return to normal conditions it may become desirable, in the interests of more uniform concrete, to obtain the cement for the whole of a constructional works from one cement factory, as was sometimes done before the war.

Aggregate Grading.—Variations in the grading of aggregate may be reduced by ordering material in several sizes and recombining them in the correct proportions at the batching stage. During the construction of the German motor-roads the aggregates were often delivered in seven different sizes or grades, but this is a refinement which would hardly seem to be necessary. In this country it is becoming increasingly common to order the coarse aggregate in two or three sizes, namely, $\frac{1}{2}$ in. to $\frac{3}{4}$ in. and $\frac{3}{4}$ in. to $1\frac{1}{2}$ in. for aggregate of $\frac{3}{4}$ -in. nominal maximum size, and $1\frac{1}{2}$ in. to $2\frac{1}{2}$ in., $\frac{3}{4}$ in. to $1\frac{1}{2}$ in., and $\frac{3}{4}$ in. to $\frac{1}{2}$ in. for aggregate of $1\frac{1}{2}$ -in. nominal maximum size.

The grading of sand cannot be adjusted so easily. Much can be done to ensure uniformity by regular sieve tests on the sand as delivered, as this will show whether there is any gradual departure from the specified grading. When the construction work is protracted, the sand

pit or quarry may be progressively working into or producing a finer or coarser grading and the sieve tests will indicate whether or not this is happening.

Bulking of Fine Aggregate.—Errors due to this cause can be entirely eliminated by batching by weight in preference to volume. If the latter must be used (and it is suggested that it never should be used) the moisture-content-bulking curve should be established by tests on the sand being used and corrections made to the volume of the gauge boxes as the moisture in the sand changes. Alternatively—and this is the least acceptable—the gauge boxes should be increased in volume by 25 per cent. over that required for dry sand, so that an average allowance is automatically made for bulking.

Batching.—Batching by weight will eliminate the high variations normally associated with batching by volume. Large storage hoppers, filled by drag-line buckets or bucket-elevators and elaborate devices for weighing are economical and generally used on large-scale works such as airports and major road works. The principles of weigh-batching can be applied just as easily on works requiring small amounts of concrete where a 10 or 7 cu. ft. mixer is used. When engineers and contractors begin to use weigh-batching they continue to use it in preference to volume-batching, because it is cheaper, more convenient, and more accurate. In the absence of specially designed plant, much can be done with a spring-balance and lever. Where volume-batching must be employed, the gauge-boxes should be deep and of small cross section to avoid excessive errors arising from filling; allowance should also be made for bulking of the fine aggregate.

Compaction.—There is no reason why adequate compaction should not be assured on all work and in all circumstances in view of the variety of compacting devices now available. The proportions and water-cement ratio should be arranged, having regard to the methods of compaction to be used, to ensure good compaction with no segregation and no laitance.

Handling.—The elimination of segregation, which sometimes occurs when concrete is transferred from mixer to dumper,

STEEL FORMS

for ***In-situ Cast*** ***Concrete***

STEEL FORMS are being used on many important Contracts, Power Stations, Flats, Reservoirs, and also in the construction of the Festival of Britain Exhibition.

THE OUTSTANDING FEATURES are

Speedy erection with safety,

Time and labour saving,

Easily handled and erected,

Every unit interchangeable,

Long life with low upkeep,

First-class design and construction,

Overcomes timber wastage,

Repetition construction simplified,

Minimum cost with maximum efficiency,

Smooth, accurate concrete surfaces.

Specifications and Quotations
on request

A. A. BYRD & CO., LIMITED

210, Terminal House,

Grosvenor Gardens, London, S.W.1.

'Phone : SLOane 5236 (2 lines).

'Grams : Byrdicom, Phone, London.

WINGET TECHNIQUES IN CONCRETE PRODUCTION

Speedy compaction of concrete to maximum density

by the Winget "Vibrocon" Vibrating Spade

In 30 seconds the Winget "Vibrocon" spade will give maximum compaction of the new, dry, mixes. The 70 m.m. ($2\frac{1}{2}$ ") diameter is used for mass concrete and the 55 m.m. ($2\frac{1}{8}$ ") for work including close reinforcement on smaller sections. Both

sizes give a high-frequency vibration of 9,000 impulses minute with engine and transmission rate only 3,000 R.P.M. There are no gears or belts, and handling is simple. There is a choice of 3 drives—petrol, electric or air power units.



Winget "Vibrocon" in use in the manufacture of concrete piles



The Winget "Vibrocon" Vibrating Spade ensures all these important requirements for successful vibration of concrete:— increased strength, less shrinkage, greater density and homogeneity; greater resistance to frost; better bond between concrete and reinforcement; better bond at construction joints; economy of materials.

Ask for No. 127 and other Winget Publications on concrete mixing, placing, batching, etc.



Winget

CONCRETE PLANT SPECIALISTS

WINGET LTD ROCHESTER
KENT ENGLAND

Tel: Smead 7276 (5 Lines) Telegrams: Wingetian Rochester

barrow, or hoist, and from these to its final position, is usually a matter of some difficulty. In many cases baffle plates in the transporting sequence are useful.

The Water-Cement Ratio.—The accurate control of the water-cement ratio requires the use of a laboratory and a technician able to determine the moisture contents of fine and coarse aggregates and to apply the results to the adjustment of the quantities of the several constituents. Whether or not such facilities are available at the site, certain proved methods of handling and storing the aggregate should be adopted to assist in the maintenance of a constant water-cement ratio. The use of stock-piles, sufficiently large to ensure that all the aggregates have been stored at the site at least 24 hours before use, will help to even out the moisture content in the pile. The mixer driver is then more easily able to control the workability of the concrete. The stock-piles should be flat-topped and not conical. It is a good plan to reserve the bottom 1 ft. to 2 ft. of the stock-pile for drainage purposes.

Standard Requirements for Railway Bridges.

THE new edition of "Requirements for Passenger Lines and Recommendations for Goods Lines of the Minister of Transport in Regard to Railway Construction and Operation" (London: H.M. Stationery Office, 1950. Price 1s. 6d.) requires that, for cast-in-situ reinforced concrete, the working tensile stress in steel reinforcement should not exceed 18,000 lb. per square inch and in precast work it should not exceed 20,000 lb. per square inch. For prestressed concrete the working stresses in the steel wires may be higher, depending on the character of the steel and its anchorage or adhesion in the concrete. Adequate thickness of concrete cover should be provided to the reinforcement, special precautions being taken where necessary on electrified lines to avoid electrolytic corrosion. The structural clearances are generally in accordance with the requirements of the edition of 1928.

COPPER STRIPS

for expansion joints

All Reinforced Concrete Engineers recognise the advantages of using copper strips for sealing joints in concrete work. Copper is ductile, will not crack under repeated bending, is non-corrosive and is unaffected by wet concrete. We specialise in the supply of perforated copper strips of all required lengths and widths for expansion joints, and shall be pleased to submit prices against detailed specification.

ALEX J. CHEETHAM LTD.

MORTON STREET • FAILSWORTH • MANCHESTER

Telephone: FAILsworth 1115/6



DS14

The Reinforced Concrete Association.

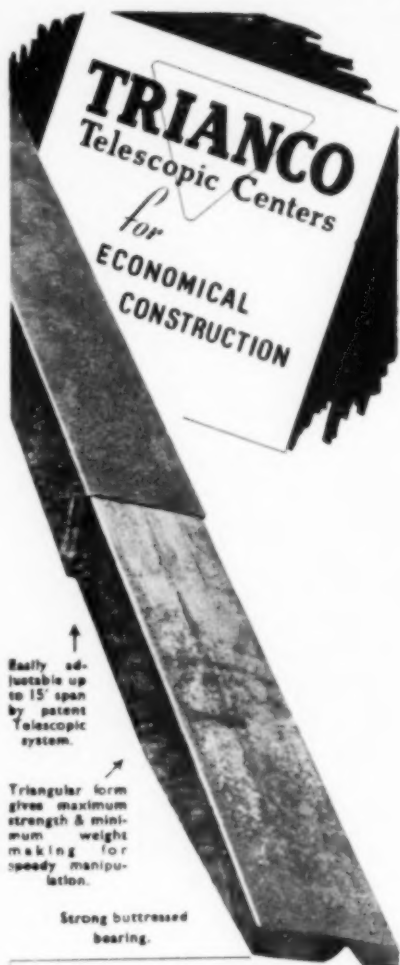
THE following notes are from the report of the Reinforced Concrete Association for the year 1949.

MEDAL AWARD.—The Council awarded the R.C.A. bronze medal for 1948 to Mr. H. G. Cousins, B.Sc., M.Inst.C.E., for his paper on "Shell Concrete Construction."

CERTIFICATION OF CONCRETING FOREMEN.—The suggestion made by Mr. J. Singleton-Green that the Association should develop means of ensuring the employment of qualified men on reinforced concrete work was considered. It was agreed that the intention was sound, and that an endeavour should be made to implement it, but that the creation of a new class of craftsmen, which would need consideration of labour rates and working rules, was undesirable and unnecessary. It was agreed that the Association's efforts should be directed rather to the training and employment of foremen, charge-hands, and gangers, and that the term "concrete craftsmen" should be avoided. It was also decided that, subject to the concurrence of the Federation of Civil Engineering Contractors and the National Federation of Building Trades Employers, the Association should, as a step towards the employment of qualified men, award certificates to two grades of foremen. This proposal was not approved by the Federations, and the Association has reluctantly abandoned it.

ECONOMY IN THE USE OF STEEL.—A suggestion submitted to the Association by the Steel Economy Committee that steel might be saved by the substitution of the ultimate-load theory for the existing basis of reinforced concrete design was considered. The Committee was advised that such a step was unlikely to have any appreciable effect. A further suggestion that the working stresses in steel of all grades might be increased was also considered, but the Council decided that the stresses permitted by the Code of Practice (CP 114) could not safely be exceeded.

Mr. A. R. Neelands (Cementation Co., Ltd.) has been elected President for the year 1950-51.



No timber is required, no carpenters' workshop on site. No obstruction beneath. For solid Concrete or Hollow Tile floor and roof construction. Instantly-adjustable up to 15 ft., adaptable for larger spans. Invaluable also for repair work. On hire from stock. Write or 'phone.

TRIANCO LTD. (D. 28)

Imber Court, East Molesey, Surrey

'Phone: Emberbrook 3300 (4 lines)

SCB*-the originators of tubular scaffolding!*

NOW OFFER

WICKHAM PATENT LIFT & FORCE

DIAPHRAGM PUMPS

**for immediate
hire or sale!**

- ★ Delivery head up to 40 feet
- ★ Suction lift up to 26 feet
- ★ No stuffing glands
- ★ Odourless

**S.G.B.****HIRE PLANT**

Is maintained in first class condition by highly skilled mechanics, thus ensuring trouble-free running whilst in operation.

Is as exclusive in design as it is in performance, it achieves more work for less effort, has a lower cost of maintenance and a longer effective life—**BECAUSE** the suction and discharge efforts are now shared equally between **TWO** diaphragms while the pump is effectively employed on **BOTH** the upward and the downward strokes.

SCAFFOLDING (GREAT BRITAIN) LTD

Plant Division:

MITCHAM, SURREY

Telephone: MITcham 3400 (18 lines)

Telegrams: SCAFCO, MITCHAM

Branches at: ABERDEEN · BIRMINGHAM · BOURNEMOUTH · BRIGHTON · BRISTOL · CAMBRIDGE
CARDIFF · DOVER · DUBLIN · DUNDEE · EDINBURGH · EXETER · GLASGOW · HULL · LEEDS
LIVERPOOL · MANCHESTER · NEWCASTLE · NOTTINGHAM · OXFORD · PLYMOUTH · PORTSMOUTH
SOUTHAMPTON · STOKE-ON-TRENT · SWANSEA

MISCELLANEOUS ADVERTISEMENTS.

Situations Wanted, 3d. a word; minimum 75. 6d. Situations Vacant, 4d. a word; minimum 10s. Other miscellaneous advertisements, 4d. a word; 10s. minimum. Box number 1s. extra.

Advertisements must reach this office by the 23rd of the month preceding publication.

SITUATIONS VACANT

SITUATION VACANT. We are requiring a man who is thoroughly experienced in the design of reinforced concrete structures. He should hold a University degree and/or A.M.Inst.C.E. The vacancy occurs in our Glasgow design office. Write in confidence to the Managing Director, Box 2363, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

SITUATION VACANT. Men who are experienced in the design of reinforced concrete structures and who hold a University degree and/or A.M.Inst.C.E. are invited to apply for a post we have vacant at our Manchester design office. Write, giving full details of experience and salary required, to the SECRETARY, Box 2364, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

NORTH THAMES GAS BOARD.

SENIOR DRAUGHTSMAN required, experienced in the design and detailing of reinforced concrete structures. The appointment is of a permanent nature, and pension terms will be discussed with short list candidates. Starting salary will be between £600 and £700 per annum, according to age, qualifications and experience. Applications, giving age and full particulars, should be sent to the STAFF CONTROLLER, NORTH THAMES GAS BOARD, 30 Kensington Church Street, London, W.8, quoting reference number 9796.

SITUATION VACANT. Reinforced concrete designer, with minimum three years' experience, required for industrial structures, including bunkers, tanks, frames, foundations, etc. Salary according to experience and ability. Apply, stating age, qualifications and experience, to PERSONNEL MANAGER, SIMON-CARVES, LTD., Stockport.

SITUATIONS VACANT. Consulting engineers require the services of several reinforced concrete designer-drafters. Salaries £150-£550, according to ability and experience. Reply particulars to OVE ARUP & PARTNERS, 5 Fitzroy Street, London, W.1.

SITUATIONS VACANT. Consulting Engineer's Office, Westminster, specialising in reinforced concrete work, has the following vacancies on permanent staff: Appointment A, Senior drafter, salary £700-£800 p.a. Appointment B, Two drafters, salary £500-£600 p.a. Applications, stating age, experience, and salary required, to Box 2404, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

SITUATION VACANT. Manager required for precast concrete floor works which is now in course of erection in the West London area. Practical and technical experience of floors is essential. Applicant will be expected to assist with the present building which, upon completion, will be taken over by him. The commencing salary will be £650 plus an output bonus. There is also a pension scheme in operation. Good opportunity for man with initiative. Write giving full details of career, etc. Box 2405, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

SITUATIONS VACANT. Reinforced concrete designers and detailers required by old-established firm of civil engineering contractors in Leeds. The positions are permanent and progressive to suitable men, and the work is varied and interesting. Write stating age, qualifications, experience, and salary required. Applicants selected for interviews will be provided with travel vouchers and reasonable out-of-pocket expenses. Apply in confidence to Box 2406, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

SITUATION VACANT. Civil Engineering Assistant required by Westminster Consulting Engineer, with varied practice. Experience in reinforced concrete essential; knowledge of structural steelwork and general engineering desirable. Write full particulars and salary required to Box 2409, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

SITUATION VACANT. Leading firm of Civil Engineers in Scotland has vacancy for an assistant to train as future Partner. Applicants should be between twenty-five and twenty-seven years of age and already have acquired considerable experience in consulting engineer's office. Cambridge University engineering degree would be an advantage and Associate Membership of the Institution of Civil Engineers essential. Some capital would be necessary. Box 2410, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

SITUATION VACANT. Required Deputy to Design Manager for engineering department in Birmingham. Should have all round experience of reinforced concrete design and able to control staff. The minimum age is 34 years, and the post offered is permanent and progressive. Salary according to qualifications and experience. Five day week and Pension Scheme in operation. Write, giving full details, to Box C.C. 991 at 191, Gresham House, London, E.C.2.

SITUATIONS VACANT. Draughtsmen-Detailers and Draughtsmen with working knowledge of reinforced concrete are invited to apply to us for progressive and responsible positions which are now open in the Manchester and Birmingham area. Write, giving full details, to Box C.E. 992 at 191, Gresham House, London, E.C.2.

SITUATION VACANT. Senior Reinforced Concrete Designer required for permanent staff of Consulting Engineer's Office in Westminster. Applicants must possess several years' experience in a responsible position in first-class reinforced concrete specialists' offices. Commencing salary £900 to £1,000 p.a. Applications, which will be treated as confidential, should give full details of age and experience. Box 2411, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

SITUATION VACANT. Designer-draughtsman required for old-established London firm of reinforced concrete engineers specialising in hollow type of floor construction. Progressive position. Write fully experience, qualifications, and salary required to Box 140, ALLARDYCE PALMER, LTD., 109 Kingsway, London, W.C.2.

SITUATIONS VACANT. Required by a reinforced concrete company, three young men aged between 20 and 23 years to train for sales staff. Salary offered £300 to £400 per annum according to qualifications. Vacancies occur in Bristol, Birmingham and London. Successful applicants will be trained by our Divisional Engineers. Write giving full details to Box C.E. 130, at Gresham House, London, E.C.2.

SITUATION VACANT. Senior engineer required for consulting engineer's office. To take charge of jobs from preliminary stages, including calculations, supervision of detailing and site work, etc., for reinforced concrete structures, including precast concrete. Knowledge of steelwork an advantage but not essential. Salary according to qualifications and experience. Please apply in writing to F. J. Samuels, 29 St. Giles High Street, London, W.C.2, stating age, qualifications, experience and salary required.

NEW ZEALAND

SCIENTIFIC AND INDUSTRIAL RESEARCH.

Applications are invited for the position of Senior Physicist or Engineer, Physics Division, Dominion Physical Laboratory (Concrete Research), Wellington, New Zealand, at a commencing salary of up to £860 N.Z. per annum. The successful applicant will be required to undertake Concrete Research in the General Physics and Building Research Division. The work will include the development of concrete and its uses, including cellular and pumice concrete: investigation of testing techniques of related materials, and of rock foundations for large structures. Experience in the use of concrete as a structural material is desirable. Applicants should possess a B.E. or M.Sc. Degree or equivalent and have had appropriate research experience. The successful applicant, if suitable, will be eventually required to take charge of the Concrete Laboratory.

Application forms, obtainable from the High Commissioner for New Zealand, 415 Strand, London, W.C.2, should be completed in duplicate and returned to him not later than 21 August, 1950.

SITUATION VACANT. Surveyor-taker-off required for London office (adjacent King's Cross Station) of reinforced concrete engineers specialising in hollow-tile type of floor construction. Write details of experience, qualifications, and salary required to Box 140, ALLARDYCE PALMER, LTD., 109 Kingsway, London, W.C.2.

**THE
LIVERSEDGE REINFORCED CONCRETE
ENGINEERING COMPANY LIMITED,
LONDON**

require immediately the following additional staff. Permanent positions and five day week.

- (a) Reinforced concrete designers, preferably with experience of project work. Salary £750-900 according to experience, etc.
- (b) Designer-detailers and draughtsmen, to work under supervision. Salary according to experience and capabilities.

Applications in confidence, stating details of experience, qualifications and age to 31a John Adam Street, Adelphi, London, W.C.2.

SITUATION WANTED.

SITUATION WANTED. Reinforced concrete and other design and detail. Expert advice available for full or part-time. Address: "Chartered Structural," c/o Winteco Ltd., 15-20 York Buildings, London, W.C.2.

WANTED.

WANTED. Twelve Trilior vibrators in good condition. State price and where lying. TARSAG, LTD., 117 Dunstall Road, Wolverhampton.

FOR SALE.

Complete concrete steam-curing plant for sale. Batch weigher and overhead bins. Conveyors, elevators, etc. Two "Liner" mixers, 200 bogies and rails. Traverse bogies. Steel doors for kilns. Steam winch, piping, etc. Box 2408, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, Westminster, S.W.1.

STEEL PIPING for sale. 5,000 feet of 3-in., 5,000 feet of 6-in., and 2,000 feet of 8-in. diameter, all screwed and socketed. 5,000 feet of 8-in. and 2,000 feet of 10-in. plain ends. Other sizes in steel and galvanised piping available for immediate delivery. Telephone: Mayfair 9651 (5 lines).

TESTING APPARATUS

MOISTURE TESTING—Famous Engineers write about "SPEEDY" **MOISTURE TESTER**: "Not only 'speedy' but can be used satisfactorily by unskilled labour during tests." Accurate; portable; non-electric; inexpensive; used extensively for rapid determination of water-content of concrete aggregates, clays and soils. Write for full particulars to (DEPT. CCE/6) THOS. ASHWORTH & Co., LTD., Burnley, Lancs.

Specialities Allied to—

CONCRETE & BUILDING PRODUCTS

Including Accelerators, Retarders, Hardeners, Waterproofers, Oilproofers, Cement Paints, etc.

For full particulars please write:

ALLIED BUILDING COMMODITIES

LITTLE ROYD, HUDDERSFIELD.

Use "**WATERTIGHT**" Products for CONCRETE results when **CONCRETING**.

"**LISCAL**" and "**QUICKSET**"

SURFACE DRESSING

Stocked at most Builders' Merchants

For Particulars apply to—

Watertight Cement Co., Ltd.
Highfurlong - Blackpool
Telephone: Poulton-le-Fylde 315

A Patent Reinforcement.

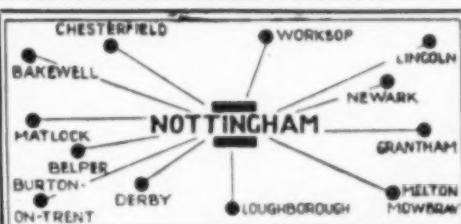
In reinforced concrete structures there are provided in place of or together with ordinary reinforcing bars, flexible concrete bars containing tensioned reinforcements. The concrete bars are formed by a steel rod or rods being placed under initial tension and concrete cast around them, the reinforcement being placed around the no-stress plane passing through the centre of gravity of the concrete bar to avoid the creation of internal bending stresses. The concrete bar may include both tensioned and untensioned reinforcements.—No. 599,774. E. J. Smedegaard. Oct. 17, 1945.

Road Congress in Portugal.

THE next congress of the Permanent International Association of Road Congresses is to be held in Lisbon next year, probably in September. The Honorary Secretary of the British Organising Committee is Mr. Thos. S. Sinclair, of the Ministry of Transport, Berkeley Square House, London, W.1.

Tower Built with Moving Forms.

ONE of eight television towers erected between Philadelphia and Pittsburgh is 126 ft. high, and the walls, which are 12 in. thick and stand on a 4-ft. raft of concrete, were built in seven days with continuously-moving forms. On the first day the wall was constructed to a height of 23 ft.



Trent Gravels
10,000 tons per week

Washed & Crushed 1½ in. to ¾ in.

We are the leading suppliers of high-class concrete aggregates in the area shown above. Prompt deliveries guaranteed and keen competitive prices quoted. Send for samples and prices.

TRENT GRAVELS LTD

ATTENBOROUGH

NOTTS

Telephone: Beeston 54255

DATA FOR PRICING REINFORCED CONCRETE.

Materials.

(Delivered in London area.)

AGGREGATES (per cu. yd.).—Washed sand, 17s.
Clean shingle: $\frac{1}{2}$ in., 15s. 2d.; $\frac{3}{4}$ in., 17s. 6d.
Thames ballast, 15s. 9d. Broken brick,
 $\frac{1}{2}$ in., 17s. 6d.
CEMENT (per ton, delivered at Charing Cross).—
Portland cement, 6 tons and upwards, 65s.
1 ton to 6 tons, 70s. Paper bags and non-
returnable jute sacks 9s. 6d. extra.
Rapid-hardening Portland, 6s. above ordinary
Portland.
"417," 87s. 6d. in 6-ton loads; paper bags
9s. 6d. extra.
Aquacrete, 31s. 6d. above ordinary Portland;
paper bags 9s. 6d. extra.
Colocrete (buff, red, and khaki), in 6-ton loads,
106s. 6d.; paper bags 9s. 6d. extra.
Snowcrete, £11 17s., inc. paper bags.
"Super-Cement," 6 tons and upwards, 96s. 6d.
(bags 8s. extra).
High-alumina cement, 1 ton and upwards,
226s. 6d. per ton; paper bags 8s. per ton
extra.
Snowcem paint, 56s. per cwt. inc. containers.
SHUTTERING.—For prices of timber, refer to S.R. &
O., 1949, No. 1079 (price 1s. 1d.) and No. 94
(price 5d.) issued by H.M. Stationery Office.
REINFORCEMENT.—Mild steel round bars (per
cwt.): $\frac{1}{2}$ in. to 2 $\frac{1}{2}$ in., 28s. 2d. $\frac{3}{4}$ in. to
 $\frac{1}{2}$ in., 29s. $\frac{1}{2}$ in., 29s. 8d. $\frac{3}{4}$ in., 31s.

Materials and Labour.

(Contracts up to £5000. Inc. 10 per cent. profit.)

PORTLAND CEMENT CONCRETE, 1 : 2 : 4.—
Foundations, 2s. 2d. per cu. ft. Columns, 2s. 5d.
per cu. ft. Beams, 2s. 5d. per cu. ft. Floor
slabs 4 in. thick, 6s. 10d. per sq. yd.; Do.,
5 in., 8s. 7d.; Do., 6 in., 10s. 3d.; Do., 7 in.,
12s. Walls 6 in. thick, 10s. 3d. per sq. yd.
Add for hoisting 3s. 6d. per cu. yd. above
ground floor level. Add for rapid-hardening
Portland cement 2s. per cu. yd.
REINFORCEMENT.—Mild steel round bars, includ-
ing cutting, bending, fixing, and wire (per
cwt.)— $\frac{1}{2}$ in. to $\frac{1}{2}$ in., 48s. 6d. $\frac{3}{4}$ in. to $\frac{1}{2}$ in.,
43s. 6d. $\frac{1}{2}$ in. to 2 $\frac{1}{2}$ in., 42s.
SHUTTERING AND SUPPORTS.—
Walls, 155s. per square.
Floors (average 10 ft. high), 160s. per square.
In small quantities, 1s. 8d. per sq. ft.
Columns, average 18 in. by 18 in. (per sq. ft.),
1s. 8d.; in narrow widths, 2s.
Beam sides and soffits, average 9 in. by 12 in.
(per sq. ft.), 2s.; in narrow widths, 2s. 2d.
Raking, cutting, and waste, 5d. per lin. ft.
Labour on splays, 3d. per lin. ft.
Small fillets to form chamfers, 6d. per lin. ft.

Wages.

The rates of wages on which the above prices
are based are: Carpenters and joiners, 3s.
per hour (carpenters 2d. a day tool money);
Labourers, 2s. 6d.; Men on mixers and
hoists, 2s. 7d.; Bar-benders, 2s. 8d.

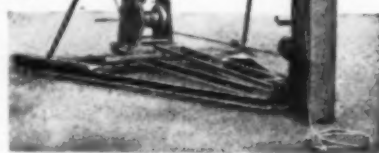
This column is specially compiled for "Concrete and
Structural Engineering," and is strictly copyright.

THE DIESEL PILE DRIVER CHEAPER to OPERATE than Compressed Air or Steam types.

For medium or light pile driving jobs.

**2 men can erect
in 30 minutes.**

Uses approx. 3 quarts of DIESEL
oil daily, employs direct combustion
within hammer itself. No
hose hoses, self-cooling, opera-
tes in all weathers, no
trouble. Immediate delivery
of model D.1 (illus.) 672
lb. dropping weight.
Model D.3 (1,232/1,456 lb.
dropping weight). Re-
mote control fuel cables,
hand-operated ground
level. Variable dropping
weights. (Also 240
lb. petrol type for
lighter work.)
See Folder D.24.
Can be mounted
on Barge, Pon-
toon, etc.; oper-
ated from
water when
river bank is
unsuitable.



JOHNSON Internal CONCRETE VIBRATORS TWO TYPES (Patented)

Extremely easy to
work in case of
intricate reinforcement.
Petrol Flex
Drive. Illus. Vibra-
tion is confined to
the "spade," thus
ensuring long life
of motor; imposes
no strain on opera-
tor; all mechanical
parts ground and
sealed for life.
Also Electric Flex
Drive and Electric
Bull Shaft models.
Write for Folder
V.24.



C. H. JOHNSON (Machinery) LTD.

DV/24, Adwood Road, Stockport

Write for details of our
CONCRETE VIBRAT-
ING MACHINES: Tables,
Internal vibrators, Flat-
form vibrators, etc.

TERMS CAN BE
ARRANGED.

For further details and full technical assistance, please telephone
our nearest representative.

Bristol: Inglegate 277. Newcastle-on-Tyne: 23810. Glasgow:
Central 2244. York: Gumsley 872. Lancs.: Gally 4404.



CEMENT TODAY—POWER TOMORROW

Britain's hydro-electrical development schemes—so vital to our national recovery—are absorbing vast quantities of cement in the construction of giant dams, power houses, bridges and kindred structures.

This is but one of the many important demands which the Blue Circle Organization, with its unrivalled resources, is being called upon to meet.

The symbol which identifies the products of the largest cement manufacturing and distributing organization in the world.



THE CEMENT MARKETING CO LTD PORTLAND HOUSE TOTHILL ST. LONDON SW1

Every
well-planned road
laid in
Reinforced Concrete
is a step nearer
to national
highway perfection

BRC

REINFORCEMENT FOR ROADS

THE BRITISH REINFORCED CONCRETE ENGINEERING CO. LTD., STAFFORD

*London, Birmingham, Bristol, Leeds, Leicester, Manchester, Newcastle, Sheffield, Cardiff, Glasgow,
Dublin, Belfast*

R-W.596